

FACILITY FORM 902

N65-27294

(ACCESSION NUMBER)

49

(PAGES)

CR 63480

(NASA CR OR TMX OR AD NUMBER)

(THRU)

1

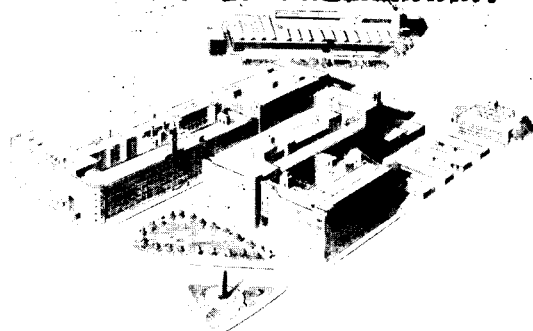
(CODE)

17

(CATEGORY)

B
&L

UNPUBLISHED PRELIMINARY



GPO PRICE \$ _____

OTS PRICE(S) \$ _____

Hard copy (HC) 2.00Microfiche (MF) .50

BAUSCH & LOMB INCORPORATED

ROCHESTER 2, NEW YORK

Grating Groove Formation in Au and Au-Ge Alloys

NONR-4277 (00) (X)

Final Report of Work in 1964

Submitted by
Bausch & Lomb Incorporated

March 26, 1965

C. Frank Mooney
Grating Research SectionNLR
R-107

Grating Groove Formation in Au and Au-Ge Alloys

NONR-4277 (00)(X)

Final Report of Work Performed

by Bausch & Lomb in 1964

Spectroscopic and Reflectance Measurements
were Made Using Naval Research Laboratory
Equipment

Submitted by

Bausch & Lomb Incorporated

March 26, 1965

C. Frank Mooney
Grating Research Section

CONTENTS

A.	SUMMARY OF CONCLUSIONS FROM 1964 CONTRACT WORK	2
B.	TEST GRATING SUMMARY SHEETS	4

A. SUMMARY OF CONCLUSIONS FROM 1964 CONTRACT

1. Gold films made under some conditions can be burnished with smooth grating grooves of some types.
 - a. Gold deposited rapidly in good vacuum is too malleable to rule well.
 - b. Gold that is somewhat less malleable can be ruled without oil.
 - c. Gold that is least malleable can be ruled with 3 degree to 7 degree blaze angles conventionally under oil.
 - d. Gold-germanium alloy films are, in contrast to pure gold, useful for grooves with a steep blaze face.
2. The electron microscope reliably estimates groove "depth" of a replicated specimen if the groove surface of the original grating is smooth and if there is little change of groove shape from one area of the grating to another. An accurate specimen replica method has been discovered and used for all of the test gratings ruled in this contract. At the very end of the experimental work done in this contract, a 2400 groove per millimeter grating with a 30 nm nominal blaze was attempted entirely under electron microscope control. The slowness of the operation combined in this case with an error of procedure to obscure the success of the project.
3. Vacuum deposition variables and lumpy conditions on the films are a main source of difficulty with plano gratings in gold.

Many of these difficulties can be avoided by using transfer films; i.e., films where the exposed surface was originally in contact with smooth polished glass. Deformation of the bonding cement seems then to limit the results.

4. Cumulative diffractance was highest generally for gratings with sharp, flat grooves that have clean groove edges. Generally, only the smooth grooved gratings had significant flux in any orders except 0, 1, and 2.
5. Most other observations are mutually contradictory. It would seem that further control of important variables is essential for detailed progress.

B. TEST GRATING SUMMARY SHEETS

Forty of the overnight test gratings made in this contract were studied in sufficient detail to warrant the preparation of summary sheets. The information is necessarily condensed and several of the notations may need to be explained.

In the summary of observations, conditions observed during filming and in ruling setup are reported. Where the same film was used or where the same deposition run was used for more than one test ruling area, the other ruling number is included.

In the groove profile, the reported measurements were made from an electron micrograph. The groove angle is not drawn to scale because the ordinate and abscissa are on different scales. The sequence of ruling the grooves is shown by an arrow. Several of the grating micrographs were not measured.

A shorthand notation on the cumulative diffractance needs to be explained:

$$\Sigma 1 = 0 + 1 \quad \text{orders combined,}$$

$$\Sigma 2 = 0 + 1 + 2 \quad \text{orders combined,}$$

$$\Sigma 3 = 0 + 1 + 2 + 3 \quad \text{orders combined.}$$

In this form of presentation, crossing curves are avoided. The spectrum scale is linear in wavenumber, but for personal comfort

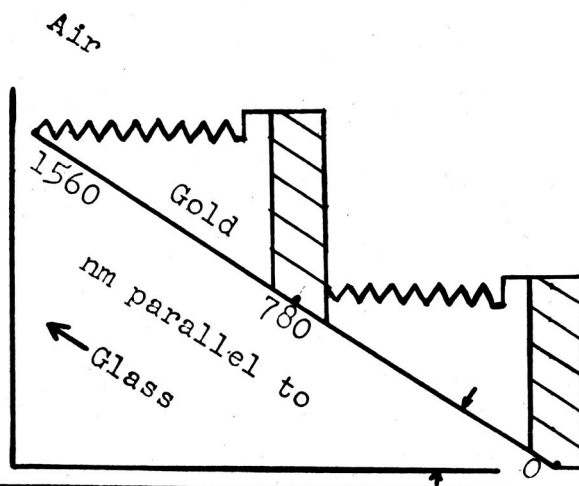
the abscissa is plotted with wavelength increasing from left to right.

Both micrographs are to the same scale. The top line of the shadow corresponds to the profile of the grating with air above and metal below but with the vertical scale exaggerated about three times.

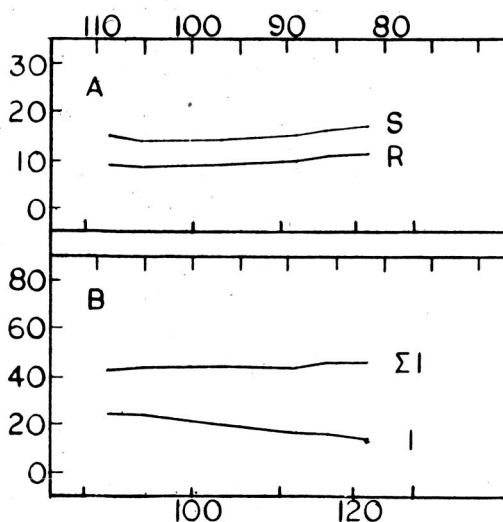
OBSERVATIONS

Substrate - Shined glass plate
 Deposition - 32 microtorr
 Electron gun, C crucible
 Au: 270 nm: .47 nm/sec
 Ruling - 1280/mm
 Steep burr, resurgent
 Au adhesion to tool locally
 Tool bounced, large nuggets
 An unruled diagonal band
 Burnishing - .3 complete
 Groove edge wave - .3 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

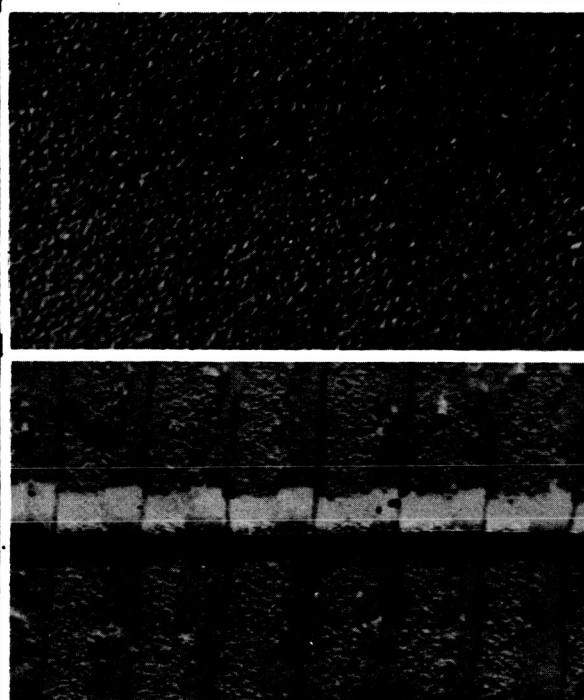


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffraction as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←

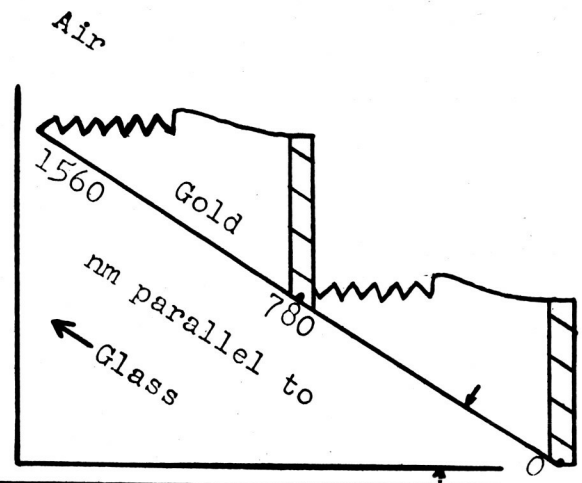


ELECTRON MICROGRAPHS

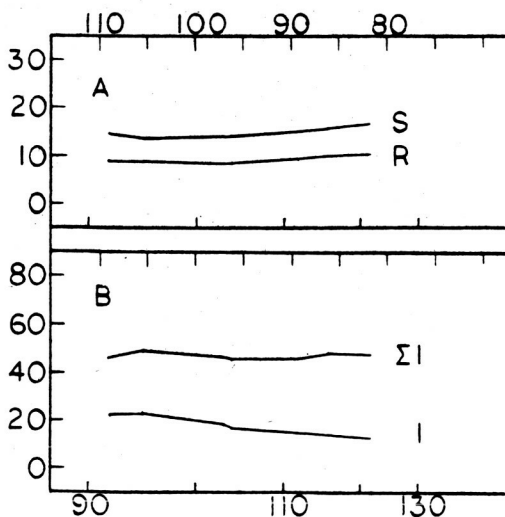
OBSERVATIONS

Substrate - Shined glass plate
 Deposition - 150 microtorr
 Electron gun, C crucible
 Au: 130 nm: .36 nm/sec
 Ruling - 1280/mm
 Slight burr step
 Grooves difficult to form,
 then poorly shaped
 Tool bounce and stripes
 Burnishing - .5 complete
 Groove edge wave - .05 groove.

SCHEMATIC FORM OF GRATING PROFILE



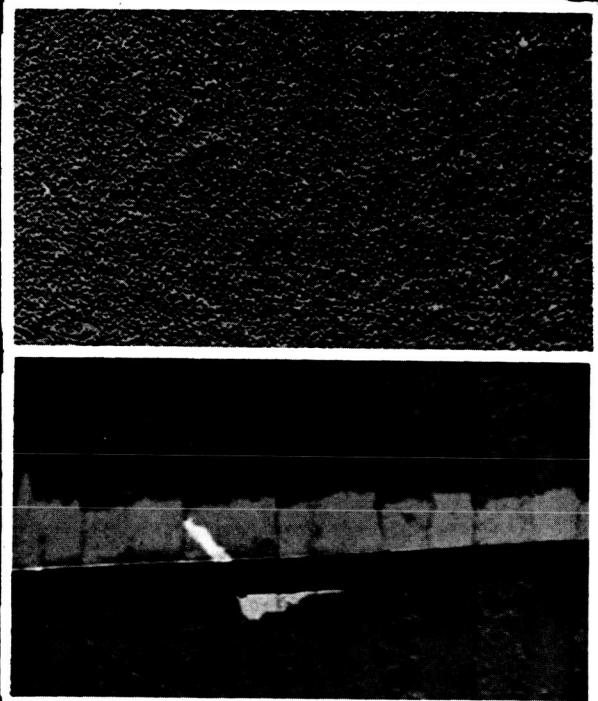
Wavenumber in Kilokaysers



Wavelength in nanometers
 A. Absolute reflectance of film
 and of "Standard (10/23/64)".
 B. Cumulative diffractance as
 % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←

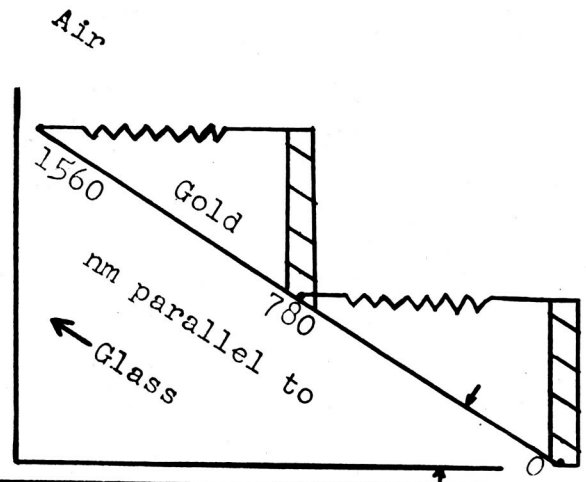


ELECTRON MICROGRAPHS

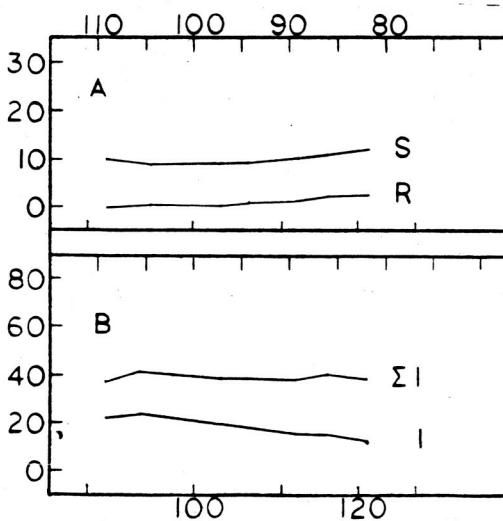
OBSERVATIONS

Substrate - Shined plate
 Deposition - 120 microtorr
 Electron gun, C crucible
 Au: 270 nm: .9 nm/sec
 Ruling - 1280/mm
 .4 fringe burr
 Some tool bounce on nuggets
 and streaks
 Grooves have good shape
 Burnishing - .6 complete
 Groove edge wave - .1 groove.

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

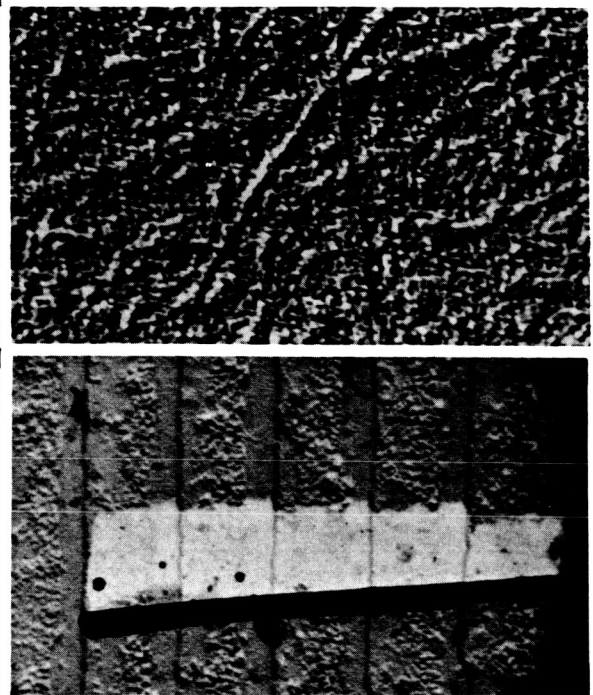


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



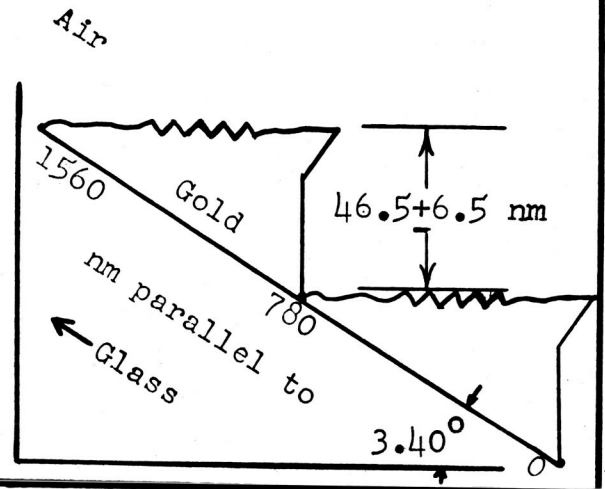
ELECTRON MICROGRAPHS

NRL 13

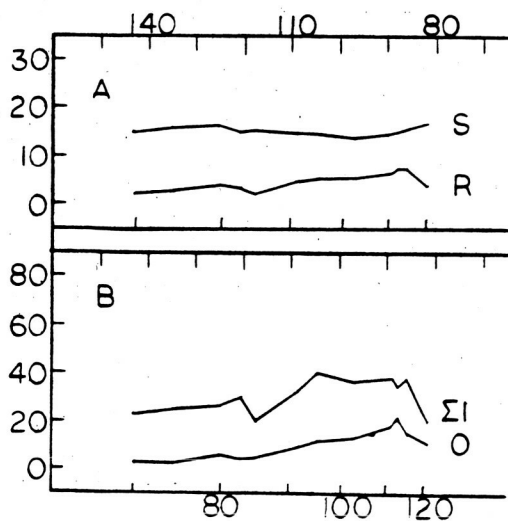
OBSERVATIONS

Substrate - Shined glass plate
 Deposition - 135 microtorr
 Electron gun, C crucible
 Au: 620 nm: .63 nm/sec
 Ruling - 1280/mm
 .3 fringe burr
 Ruling bothered by nuggets
 and tool bounce
 Rough groove profile
 Burnishing - .4 complete
 Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

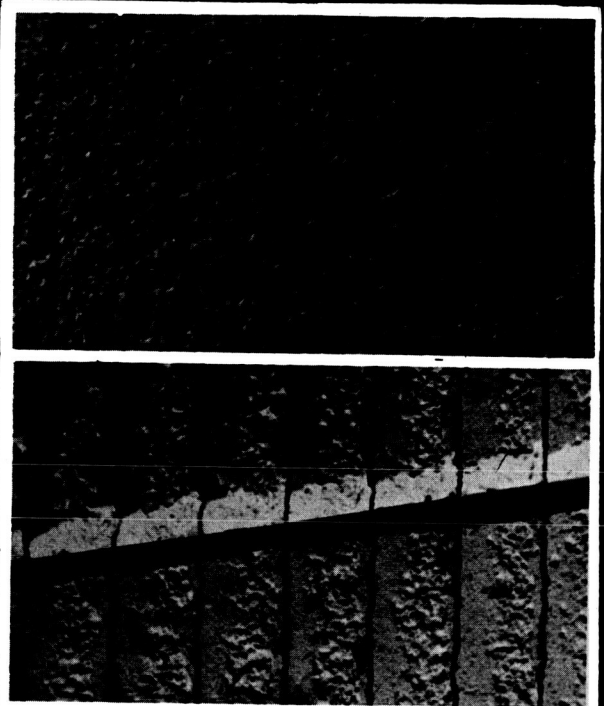


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffraction as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

OBSERVATIONS

Substrate - Shined glass plate

Deposition - 50 microtorr

Electron gun, C crucible

Au: 760 nm: 6.3 nm/sec

Ruling - 1280/mm

.3 fringe burr

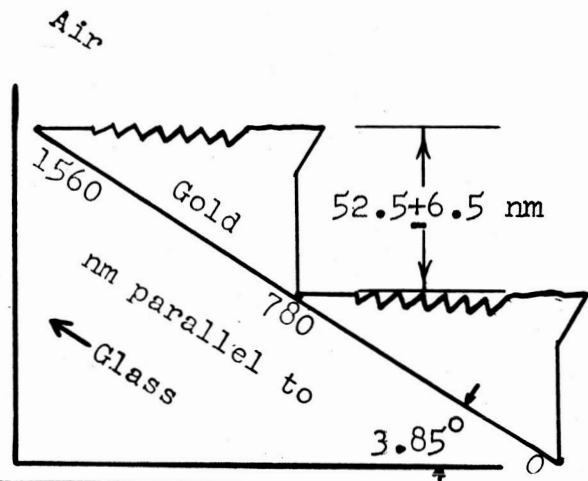
Excessive interaction of
tool with nuggets

Burnished groove areas smooth

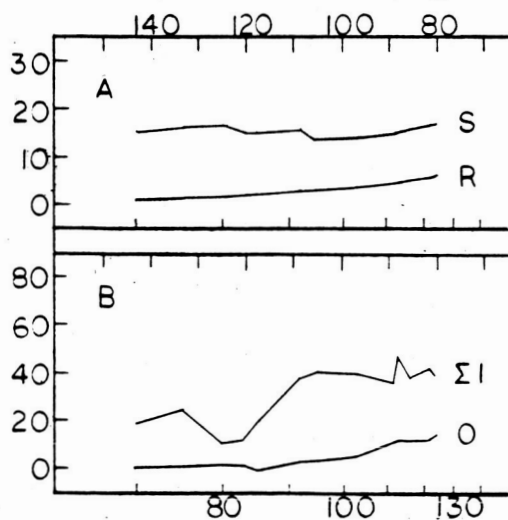
Burnishing - .4 complete

Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



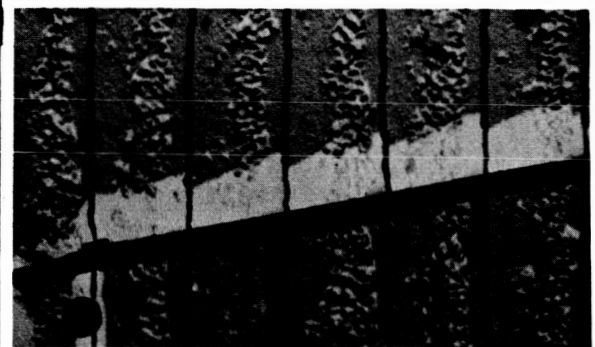
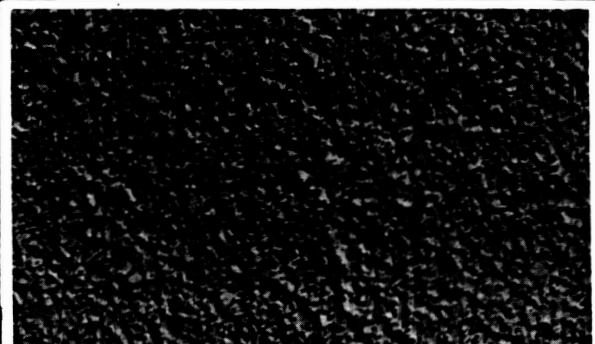
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

2,000 nm



ELECTRON MICROGRAPHS

NRL 15

OBSERVATIONS

Substrate - Shined glass plate

Deposition - 120 microtorr

Electron gun, C crucible

Au: 400 nm: .34 nm/sec

Ruling - 1280/mm

.7 fringe burr, resurgent

Ruled well despite burr

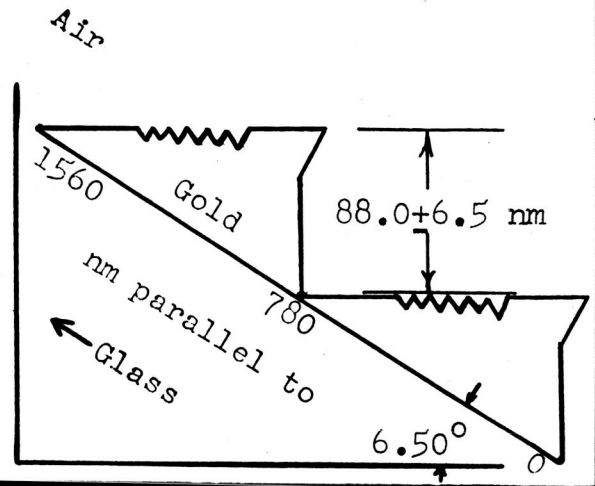
Small jumps and streaks

Heavy streaks in one section

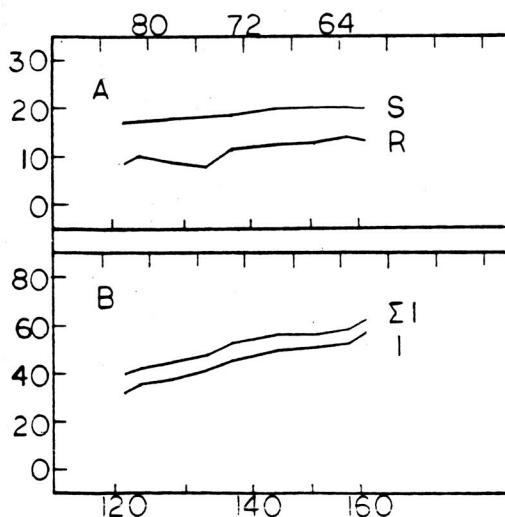
Burnishing - .7 complete

Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



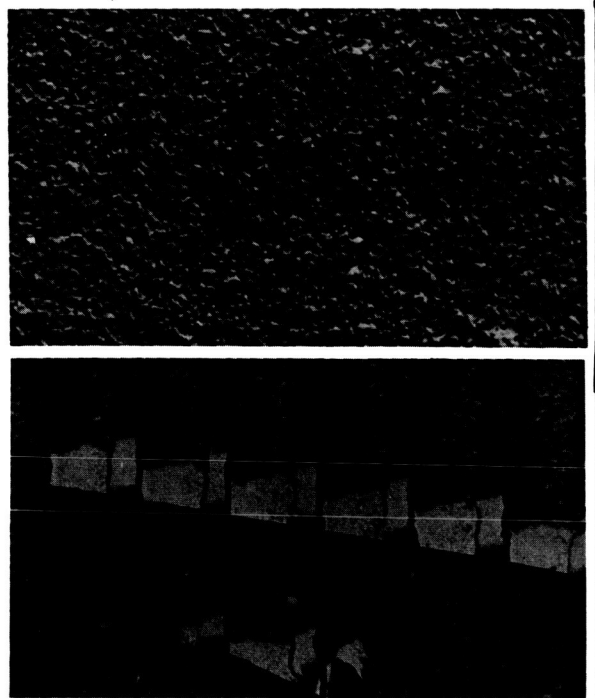
Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)".

B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



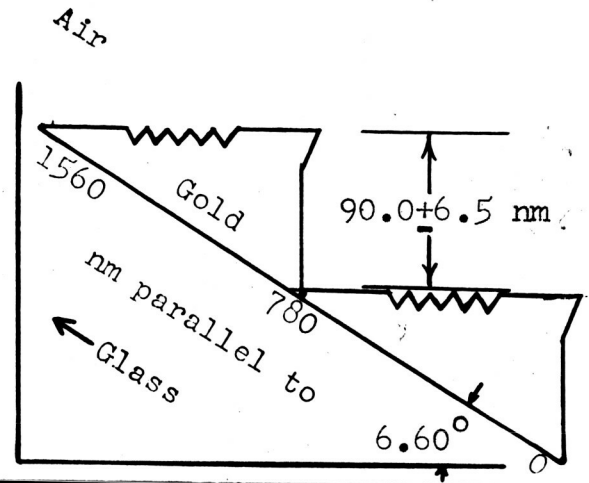
ELECTRON MICROGRAPHS

NRL 16

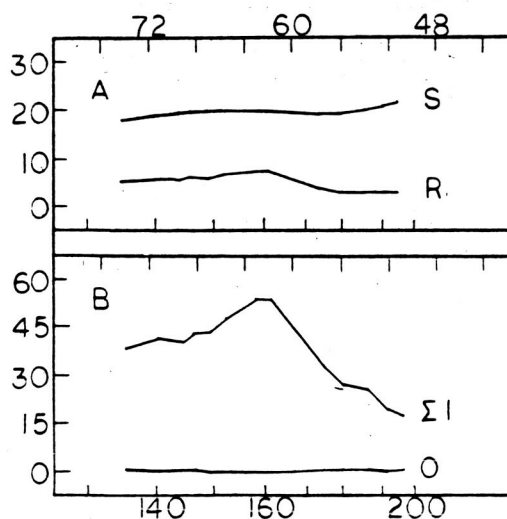
OBSERVATIONS

Substrate - Shined glass plate
 Deposition - 55 microtorr
 Electron gun, C crucible
 Au: 1100 nm: 9.2 nm/sec
 Ruling - 1280/mm
 .6 fringe burr
 Ruled well, grooves smooth
 Ruling streaks everywhere
 Center of ruling poorer
 Burnishing - .7 complete
 Groove edge wave - .15 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

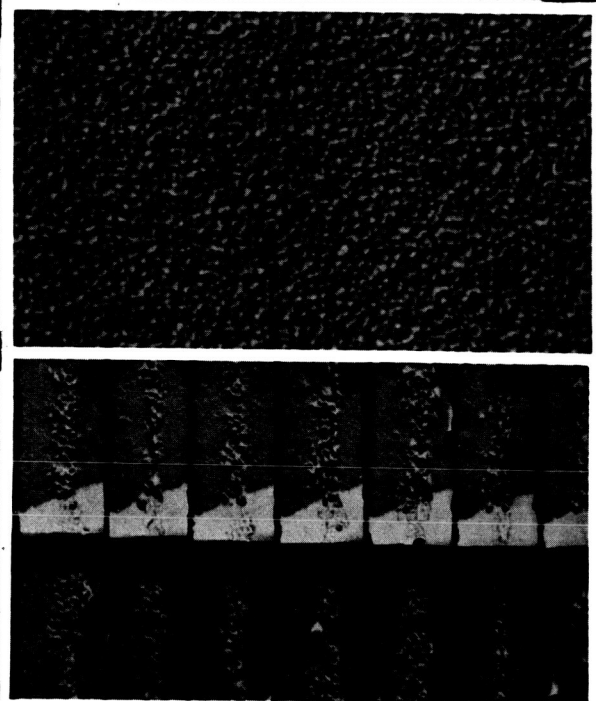


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffraction as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 17

OBSERVATIONS

Substrate - Shined glass plate

Deposition - 60 microtorr

Electron gun, C crucible

Au: 1650 nm: 12 nm/sec

Ruling - 1280/mm

.7 fringe burr

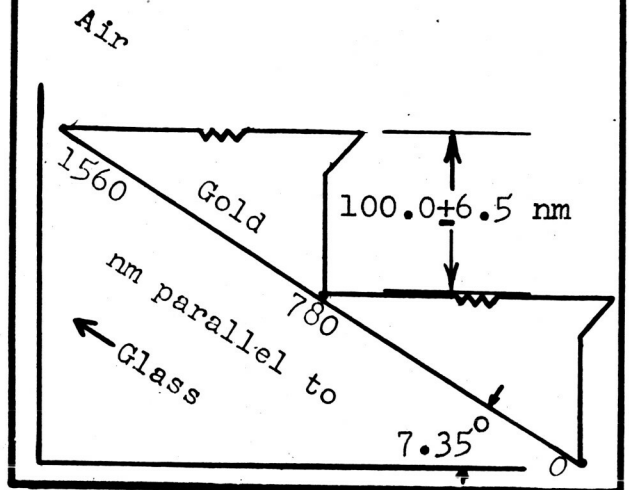
Ruled smoothly with streaks
and jumps at nuggets

Good appearance

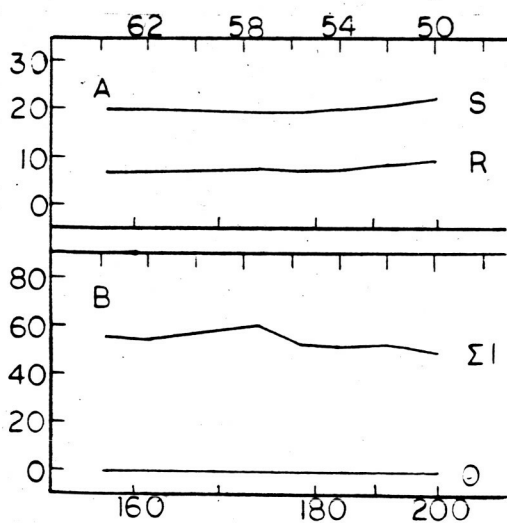
Burnishing - .8 complete

Groove edge wave - .3 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



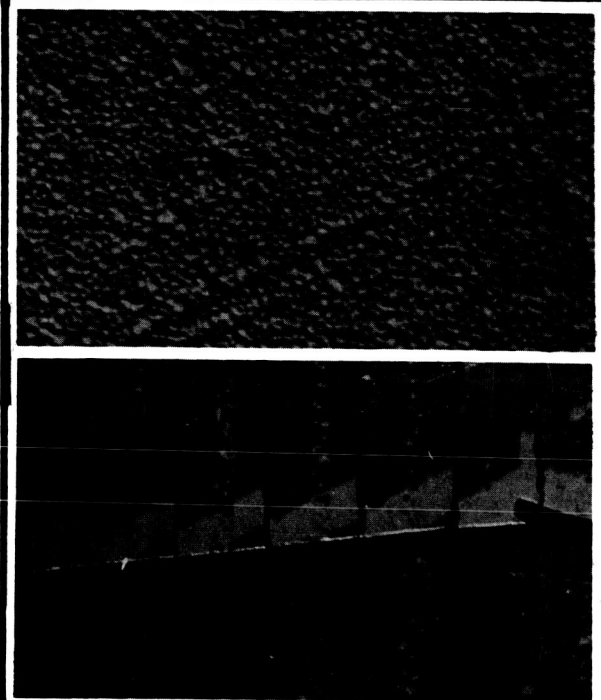
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 19

OBSERVATIONS

Substrate - Shined glass plate

Deposition - 40 microtorr

Electron gun, C crucible

Au: 1090 nm: 13.5 nm/sec

Ruling - 1280/mm

.8 fringe burr

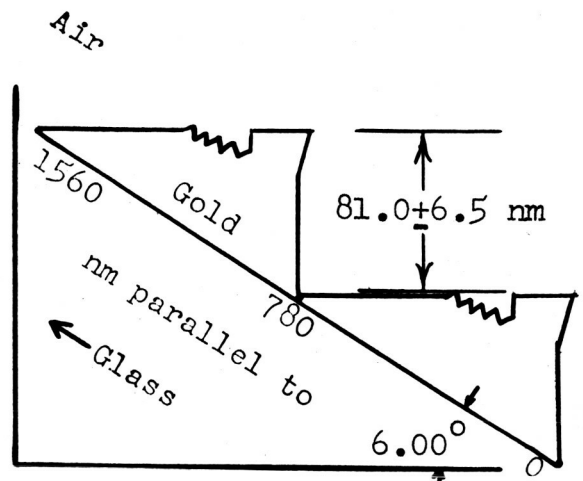
Ruled poorly, much jumping
and prominent streaks

Large resurgent burr

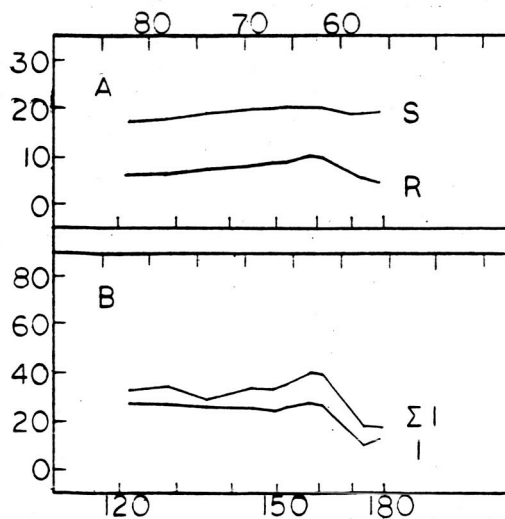
Burnishing - .6 complete

Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



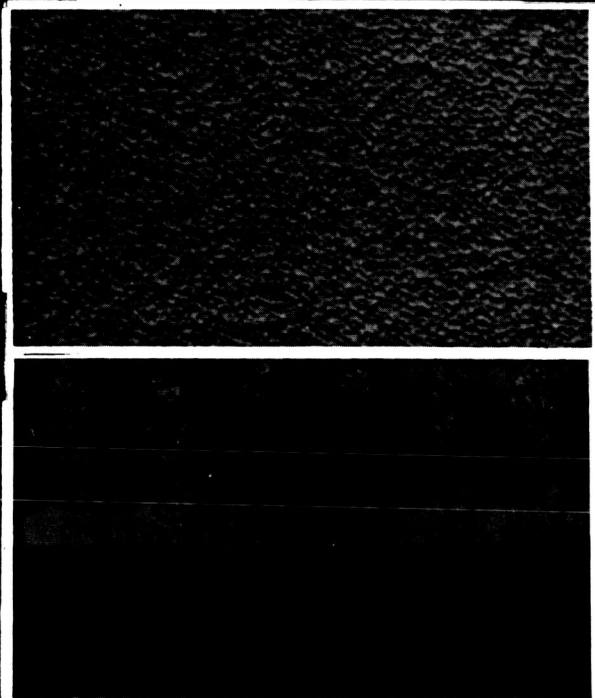
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 20

OBSERVATIONS

Substrate - Shined glass plate

Deposition -

Joule heated source

Au: very thin: very fast

Ruling - 1280/mm, Dry

High burr

Could not rule with oil,

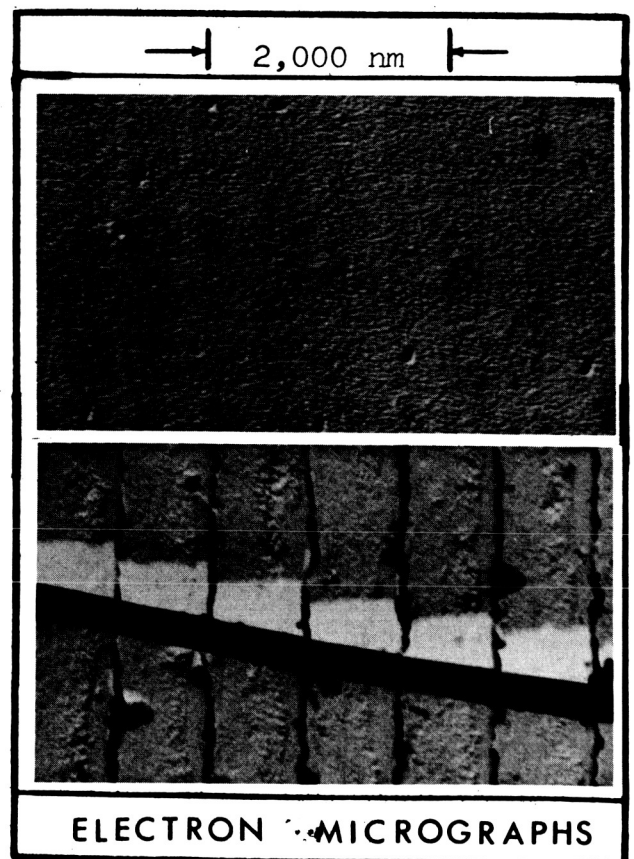
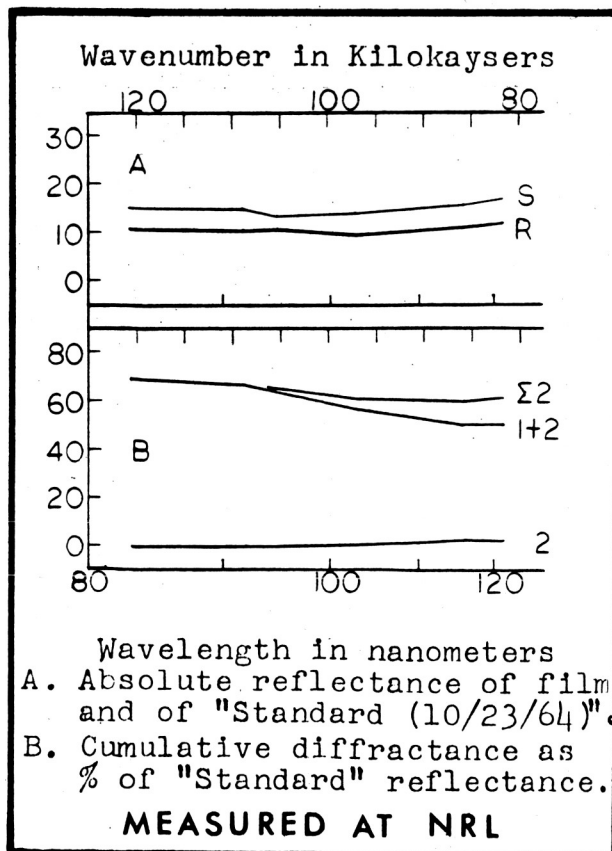
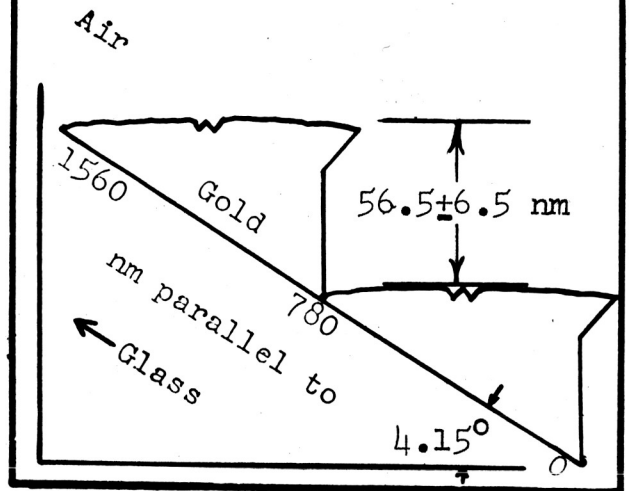
Grooves improved toward end

Best groove form to that time

Burnishing - .9 complete

Groove edge wave - .25 groove

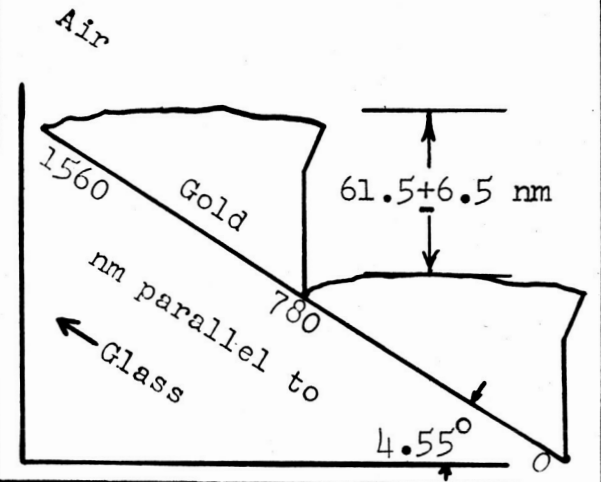
SCHEMATIC FORM OF GRATING PROFILE



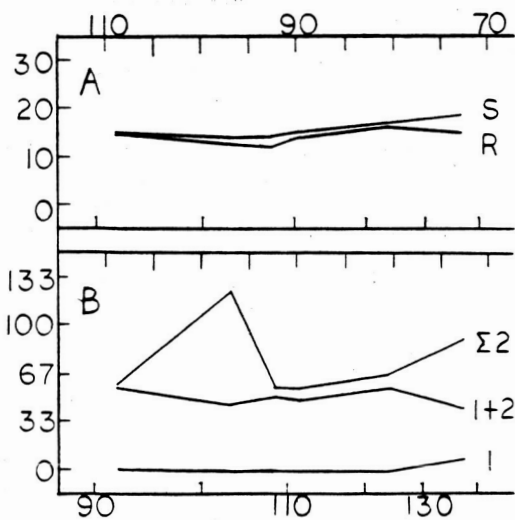
OBSERVATIONS

Substrate - Transfer film
 Deposition - 40 microtorr
 Electron gun, C crucible
 Au: 320 nm: 5.3 nm/sec
 Ruling - 1280/mm
 .3 fringe burr
 Au adhesion to tool caused occasional streaks
 Particularly free of nuggets
 Burnishing - .8 complete
 Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

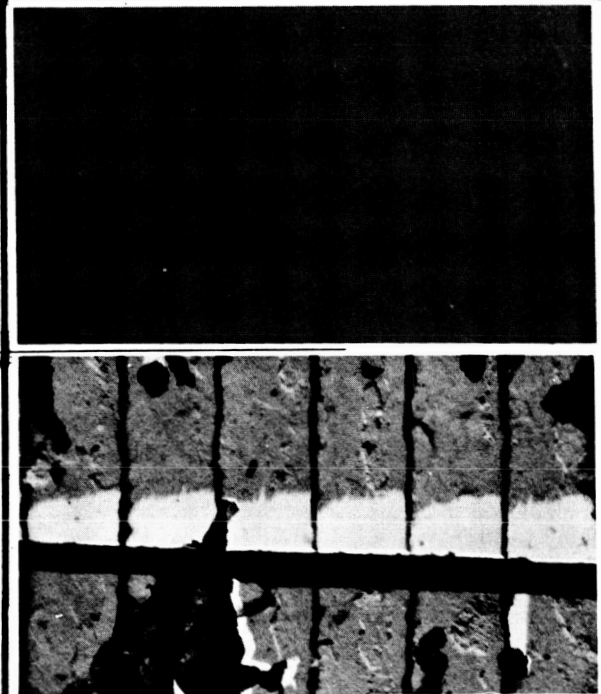


Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffraction as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 22

OBSERVATIONS

Substrate - Shined glass plate

Deposition - 50 microtorr

Electron gun, C crucible

Au: 520 nm: 5.5 nm/sec

Ruling - 1280/nm, dry

.5 fringe burr

Some Au adhesion to tool,

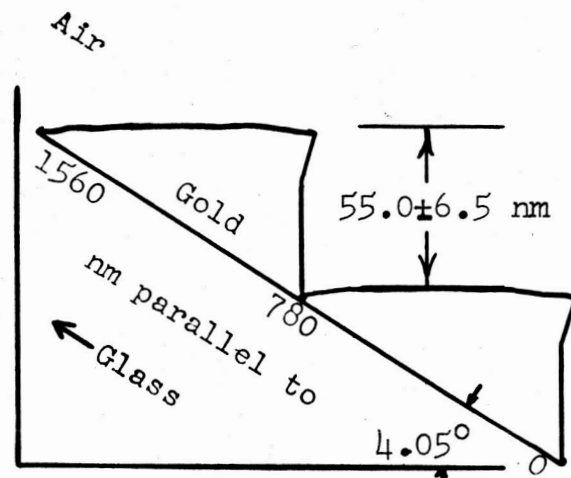
Ruled well

Nugget clusters caused jumps

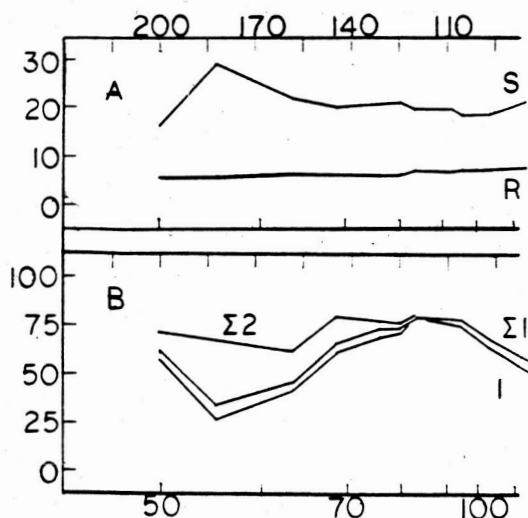
Burnishing - complete

Groove edge wave - .15 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



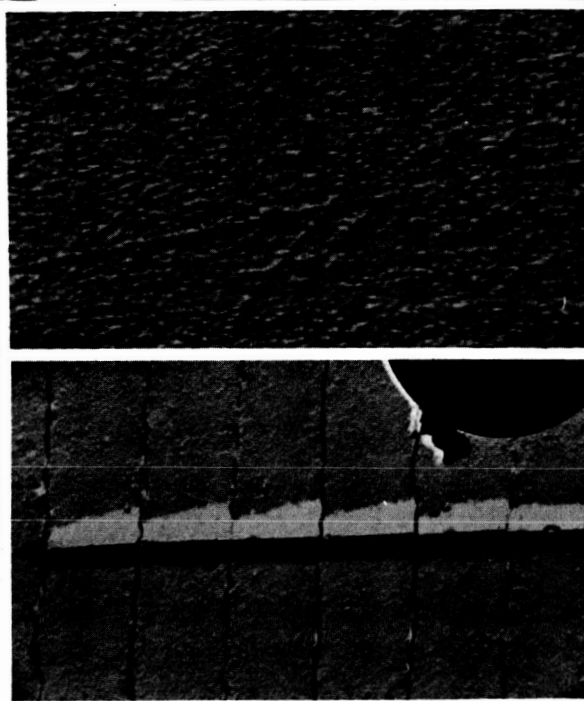
Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)".

B. Cumulative diffraction as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



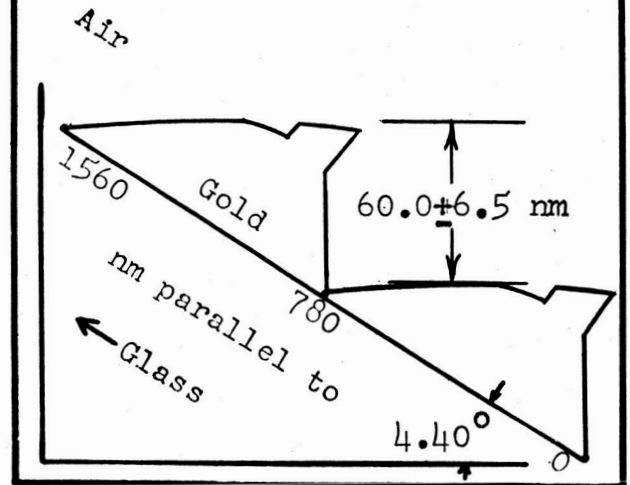
ELECTRON MICROGRAPHS

NRL 23

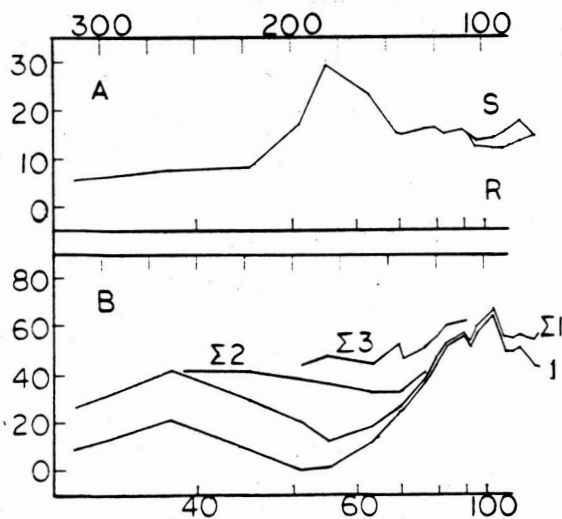
OBSERVATIONS

Substrate - Transfer film
 Deposition - 90 microtorr
 Electron gun, C crucible
 Au: 680 nm: 7.5 nm/sec
 Ruling - 1280/mm
 .4 fringe burr
 Ruled particularly well from
 start to finish
 Exceptionally good film
 Burnishing - .9 complete
 Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



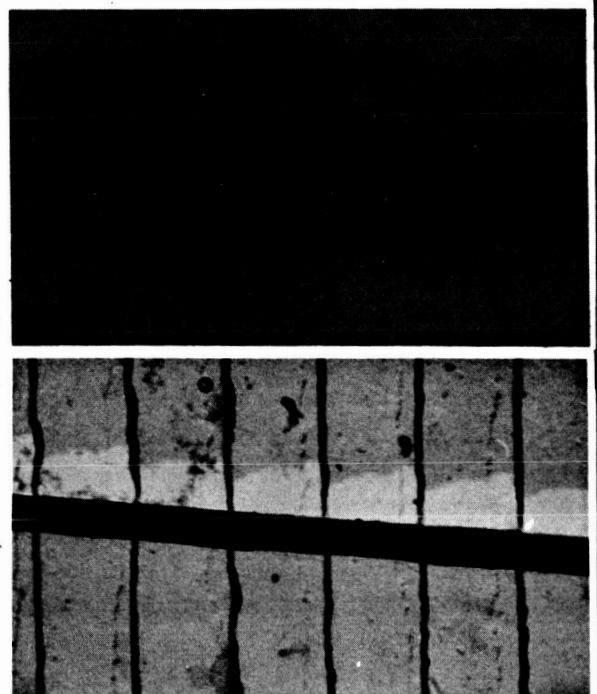
Wavenumber in Kilokaysers



Wavelength in nanometers
 A. Absolute reflectance of film
 and of "Standard (10/23/64)".
 B. Cumulative diffraction as
 % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 24

OBSERVATIONS

Substrate - Shined glass plate

Deposition - 75 microterr

Electron gun, C crucible

Au: 1100 nm: 9.2 nm/sec

Ruling- 1280/mm, dry

.4 fringe burr

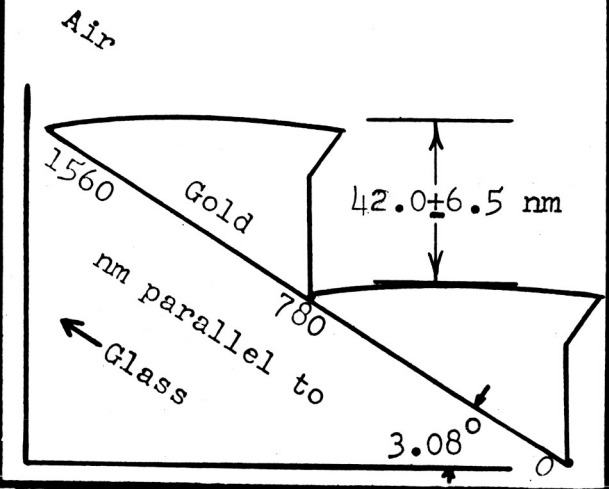
Streaking, tool disturbed
by nuggets

Exceptionally bright finish

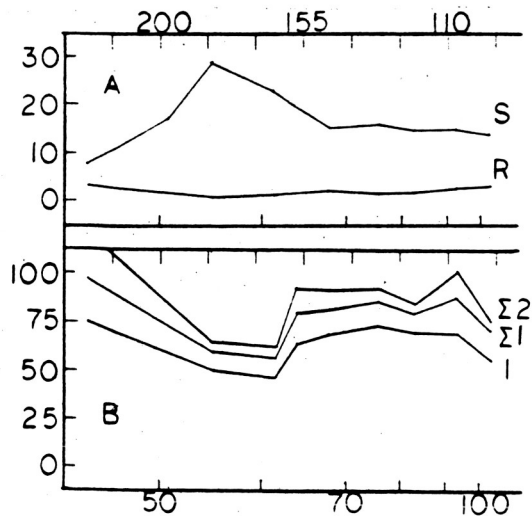
Burnishing - complete

Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



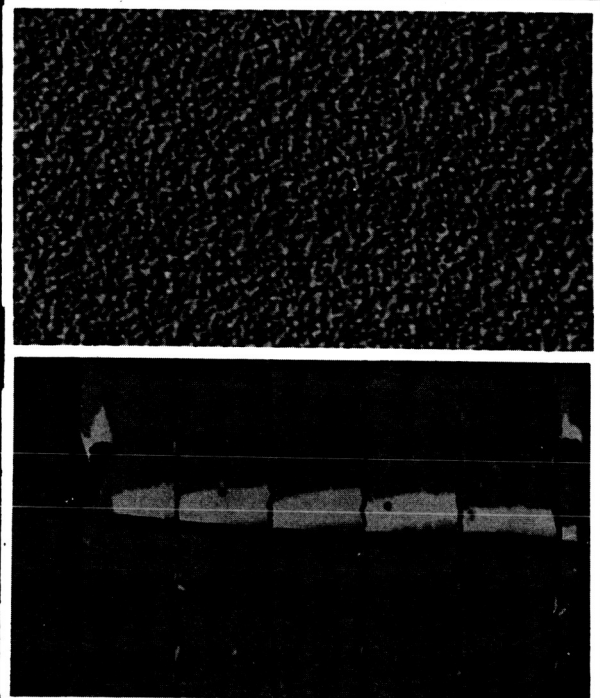
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



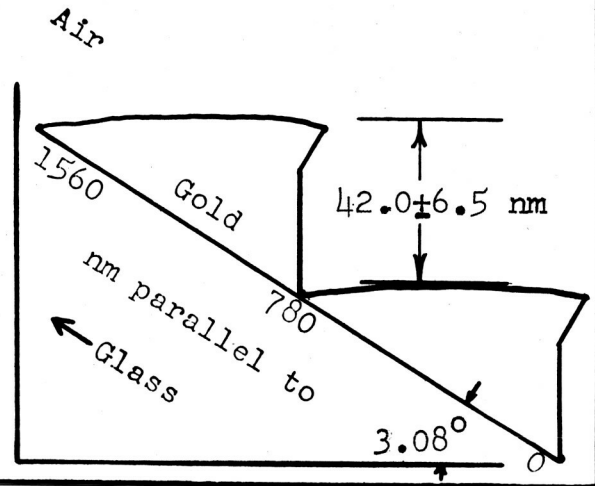
ELECTRON MICROGRAPHS

NRL 25

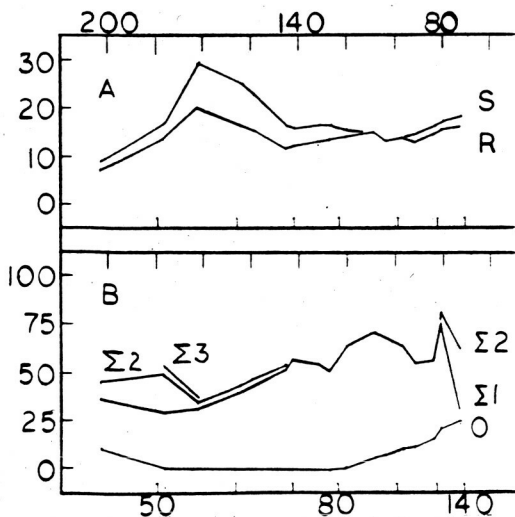
OBSERVATIONS

Substrate - Transfer film
 Deposition - 100 microtorr
 Electron gun, C crucible
 Au: 820 nm: 14 nm /sec
 Ruling - 1280/mm, dry
 .3 fringe burr
 Ruled well
 No streaks
 Some traced burr remains
 Burnishing - Complete, burr
 Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



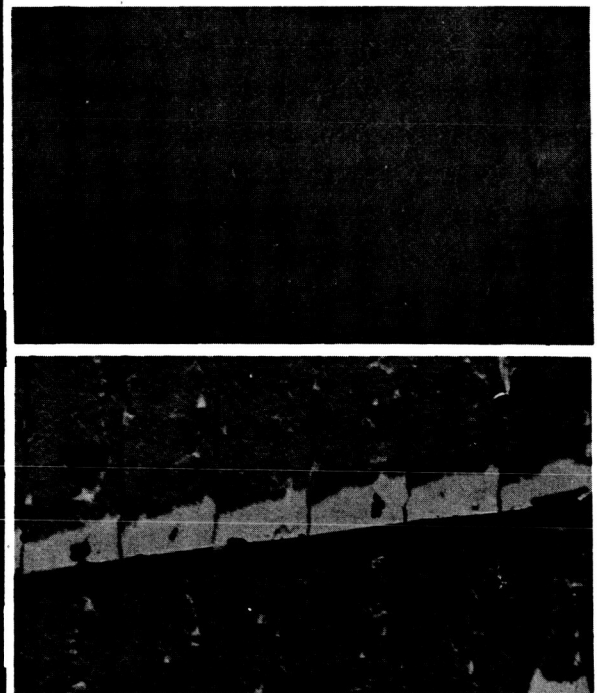
Wavenumber in Kilokaysers



Wavelength in nanometers
 A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 26

OBSERVATIONS

Substrate - (=25) Transfer film

Deposition - 100 microtorr

Electron gun, C crucible

Au: 820 nm: 14 nm/sec

Ruling - 1280/mm, oil

.2 fringe burr

Numerous streaks appeared

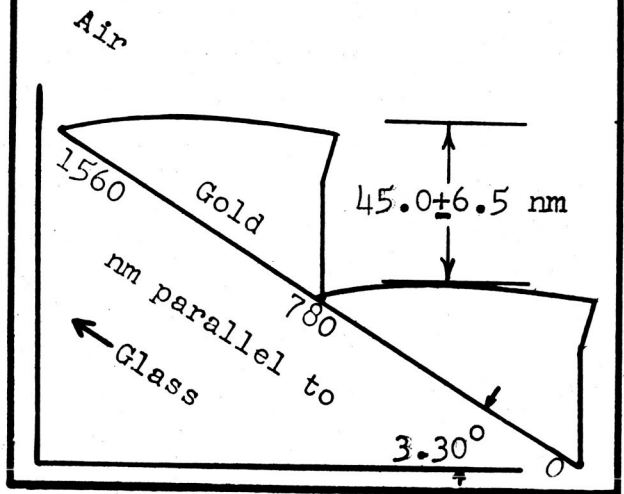
Ruled poorly

Duller than 25 but less burr

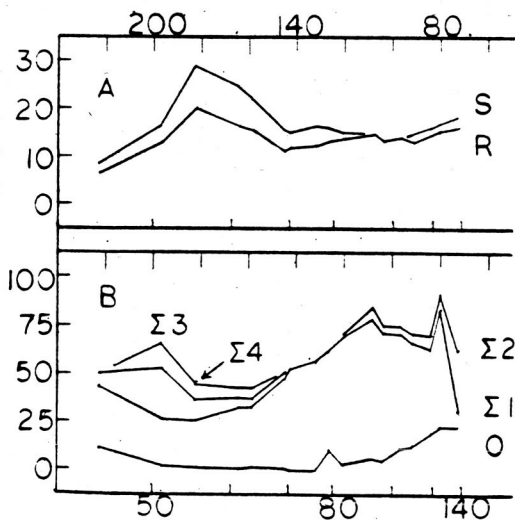
Burnishing - Complete

Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



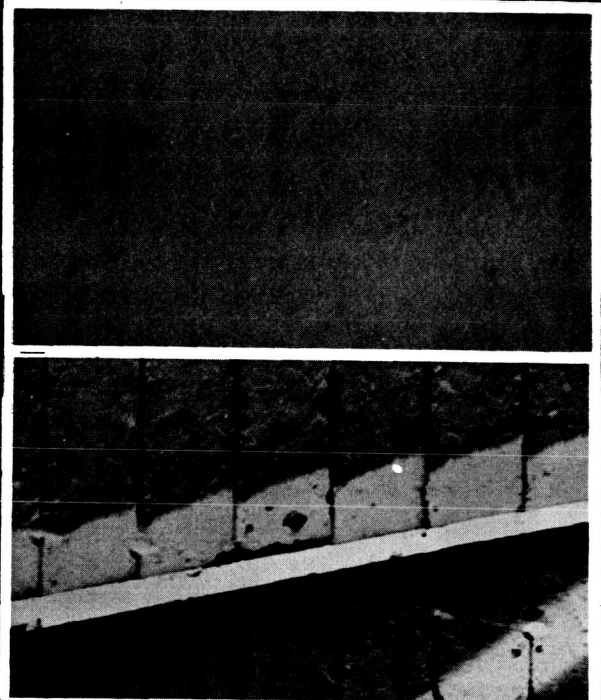
Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)"

B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

OBSERVATIONS

Substrate- (=29) Transfer film

Deposition - 60 microtorr

Electron gun, C crucible

Au: 380 nm: 6.3 nm/sec

Ruling - 1280/mm, dry

.3 fringe burr

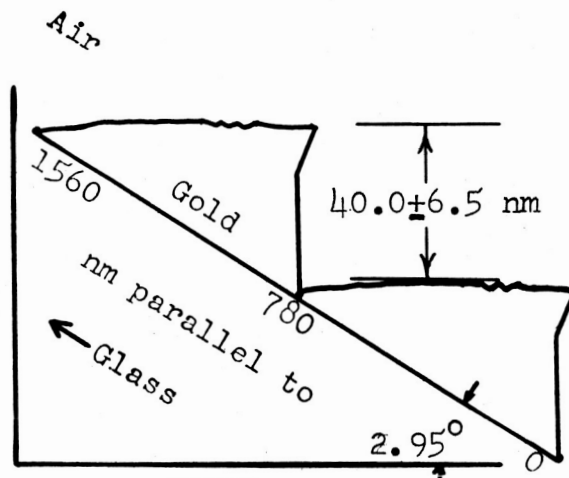
Flat groove face not clear,
some streaks

Good appearance, Mesa texture

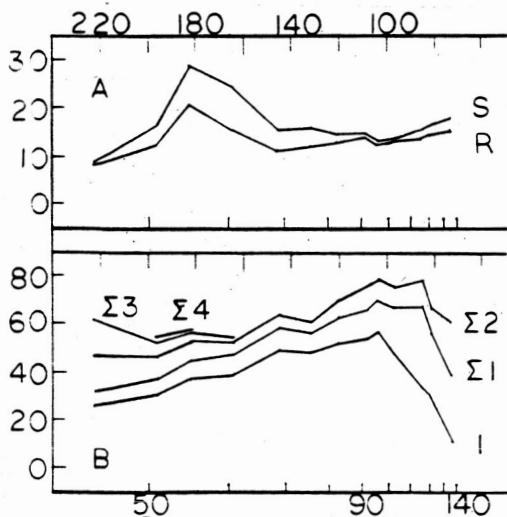
Burnishing - Complete

Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



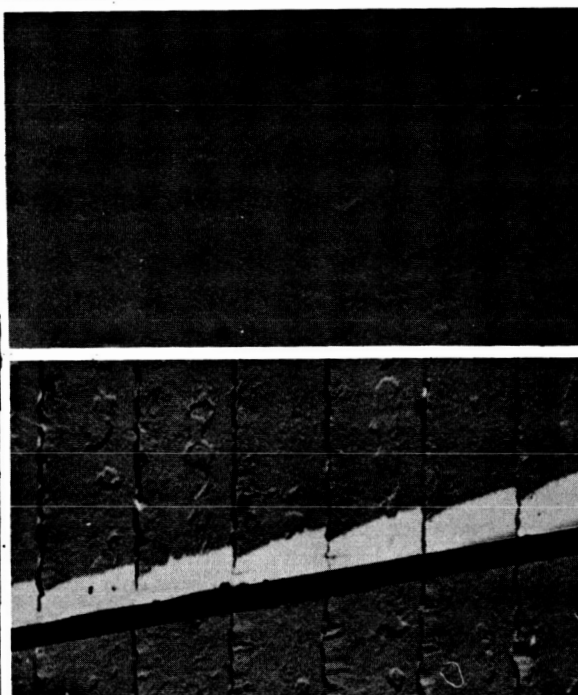
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffraction as
% of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 29

OBSERVATIONS

Substrate - (=28) Transfer film

Deposition - 60 microtorr

Electron gun, C crucible

Au: 380 nm: 6.3nm/sec

Ruling - 1280/nm, oil

.4 fringe burr

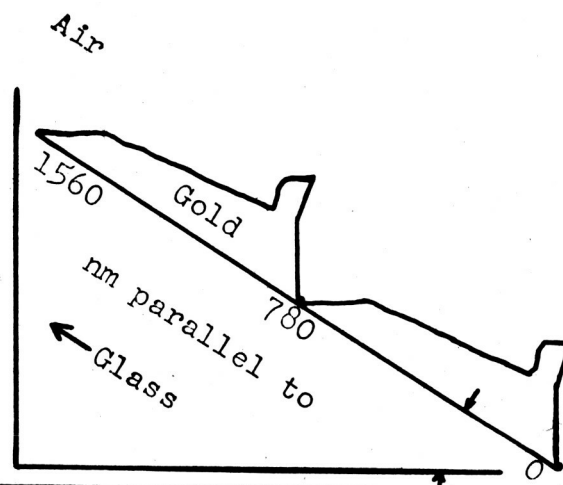
Ruled area inferior to test lines, more streaks

NRL 28 appeared better

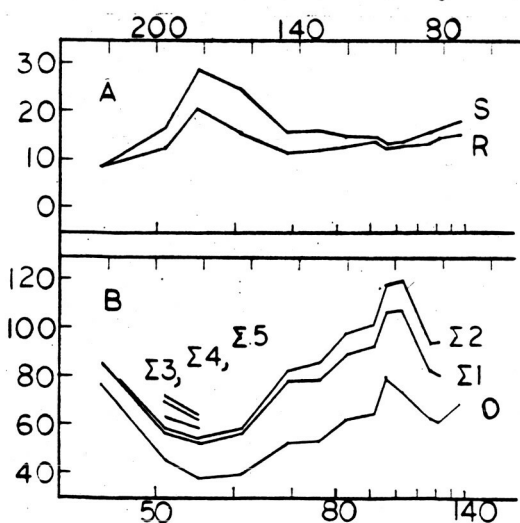
Burnishing - Complete, burr

Groove edge wave - .05 groove.

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

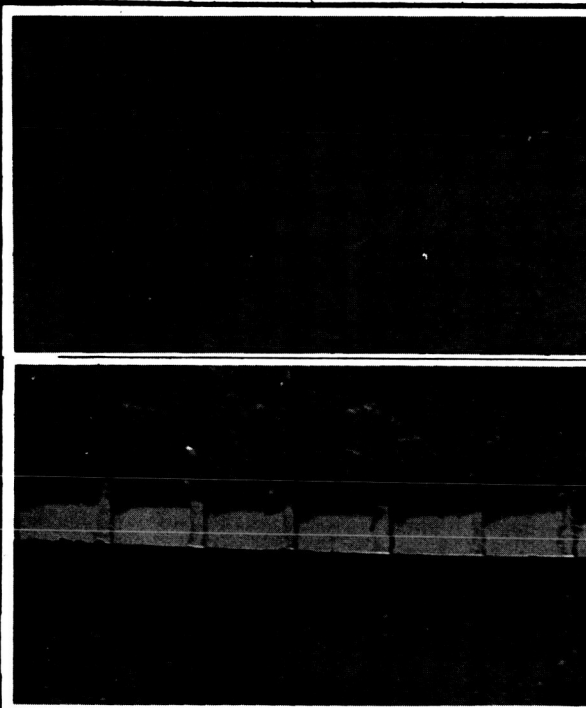


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)"
- B. Cumulative diffraction as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



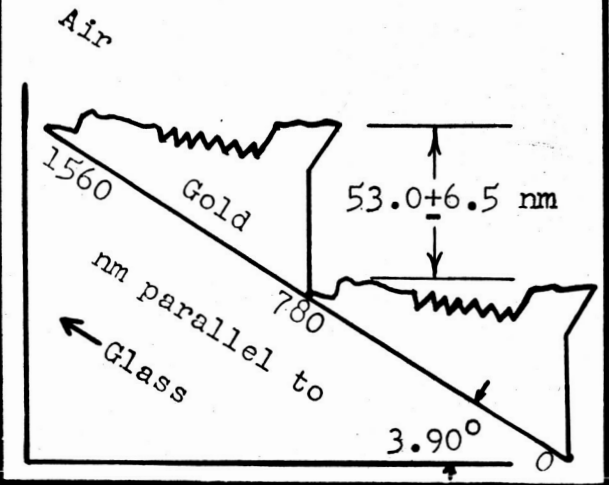
ELECTRON MICROGRAPHS

NRL 30

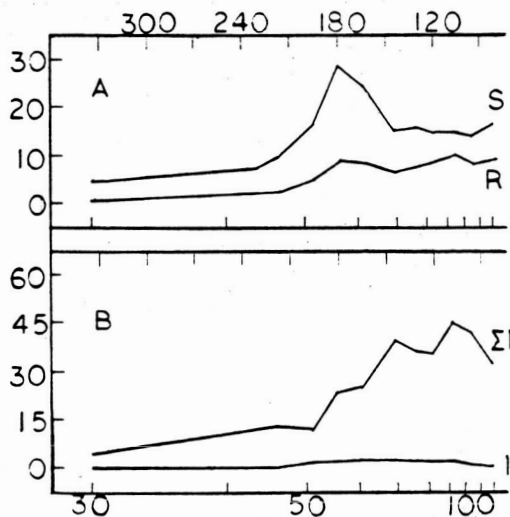
OBSERVATIONS

Substrate - Polished glass
 Deposition - With NRL 31
 40 microtorr
 Electron gun, C crucible
 Au: 250 nm: 2.1 nm/sec
 Ruling - 1280/nm
 .4 fringe burr
 Ruled well but some
 streaky sections
 Not a good ruling
 Burnishing - variable, burr
 Groove edge wave - .3 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

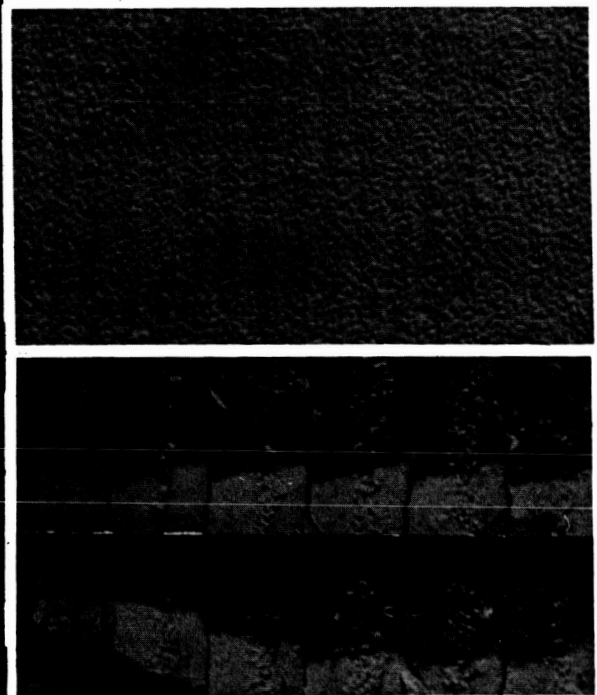


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



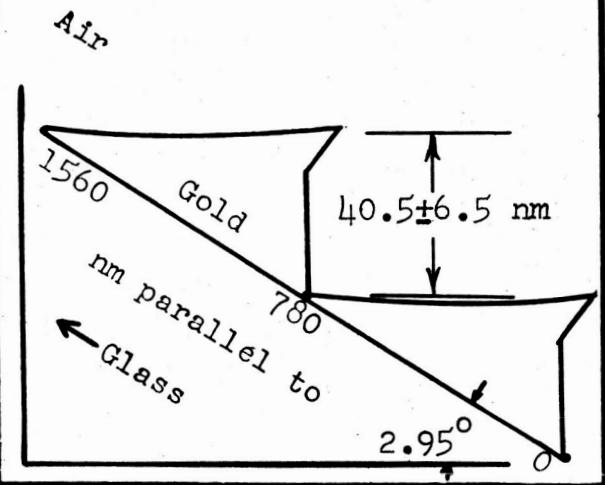
ELECTRON MICROGRAPHS

NRL 31

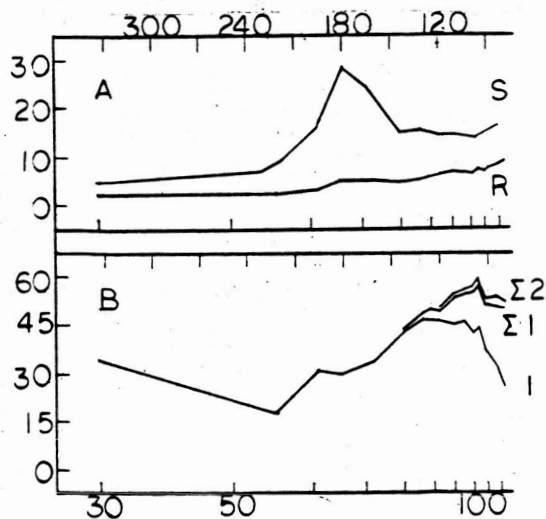
OBSERVATIONS

Substrate - Shined glass plate
 Deposition - With NRL 30
 40 microtorr
 Electron gun, C crucible
 Au: 250 nm: 2.1 nm/sec
 Ruling - 1280/nm
 .4 fringe burr
 Did not rule well due
 to nuggets
 Good locally
 Burnishing - Complete
 Groove edge wave - .3 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

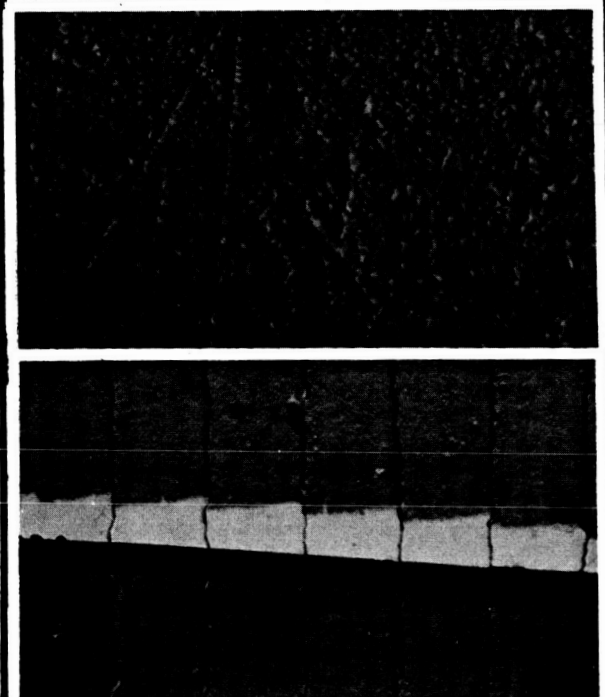


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)"
 B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



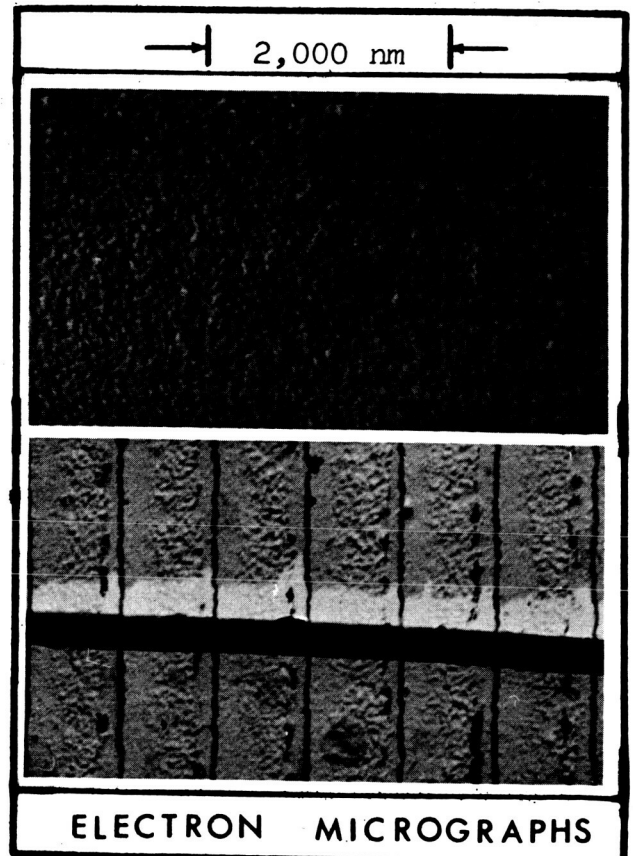
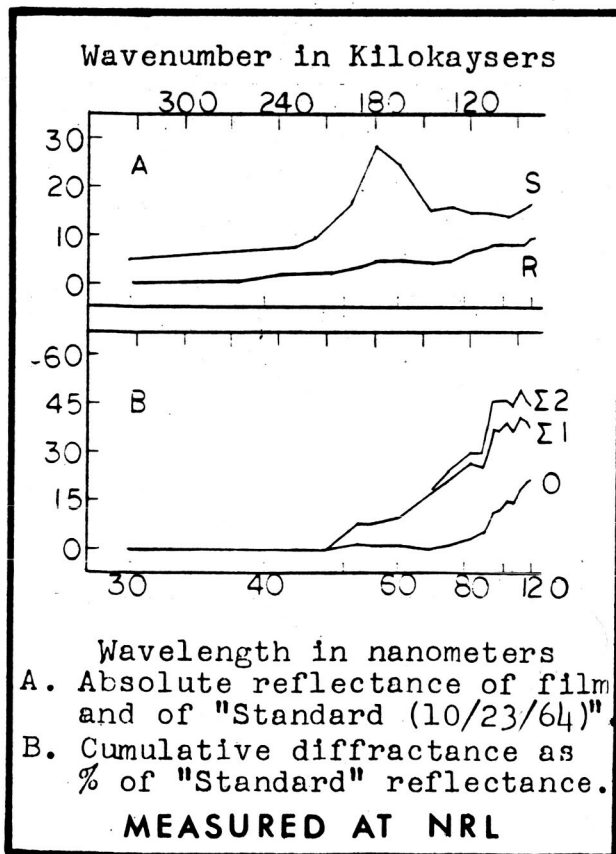
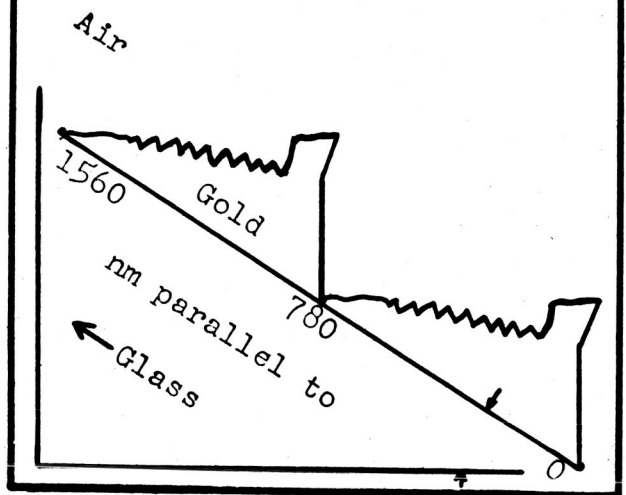
ELECTRON MICROGRAPHS

NRL 32

OBSERVATIONS

Substrate - Polished glass
 Deposition - 35 microtorr
 Electron gun, C crucible
 Aug8 Ge₁₂: 270 nm: 2.6 nm/sec
 Ruling - 1280/mm
 .1 fringe burr
 Film not easily burnished,
 jumps over nuggets
 Ruled well but not thoroughly
 Burnishing - .2 Complete
 Groove edge wave - .05 groove

SCHEMATIC FORM OF GRATING PROFILE

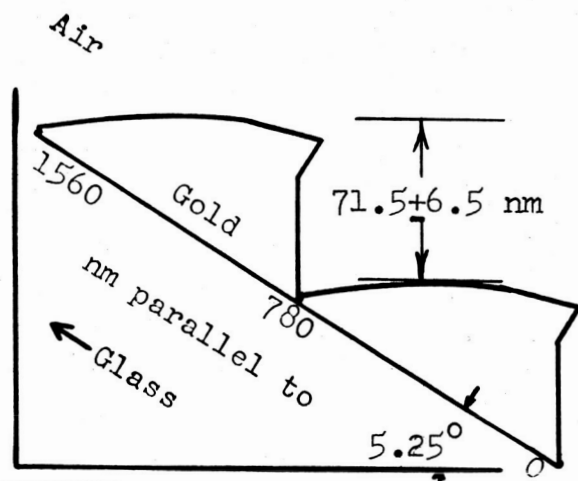


NRL 33

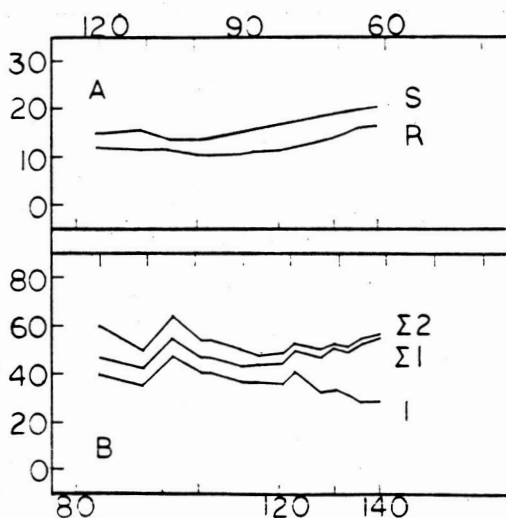
OBSERVATIONS

Substrate - (=34) Transfer film
 Deposition - 35 microtorr
 Electron gun, C crucible
 Au: 140 nm: .11 nm/sec
 Ruling - 1280/mm, dry
 .2 fringe burr
 Ruled well, disturbed cement
 not full depth
 Blank shifted near end
 Burnishing - .5 Complete
 Groove edge wave - .15 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

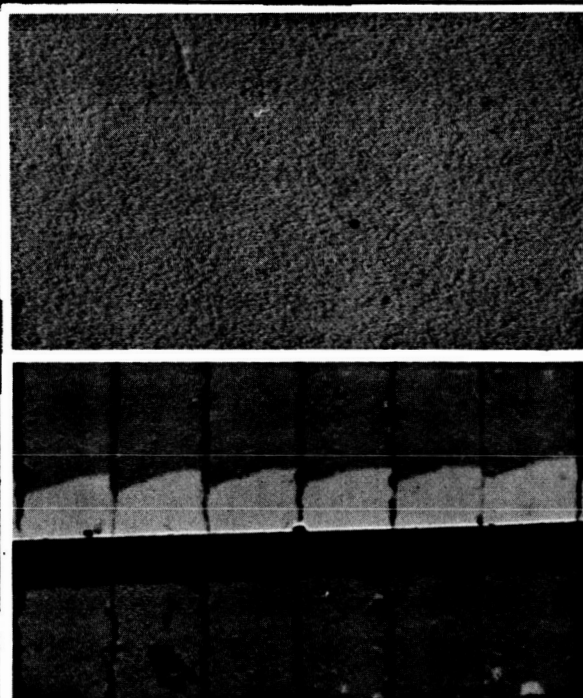


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

2,000 nm

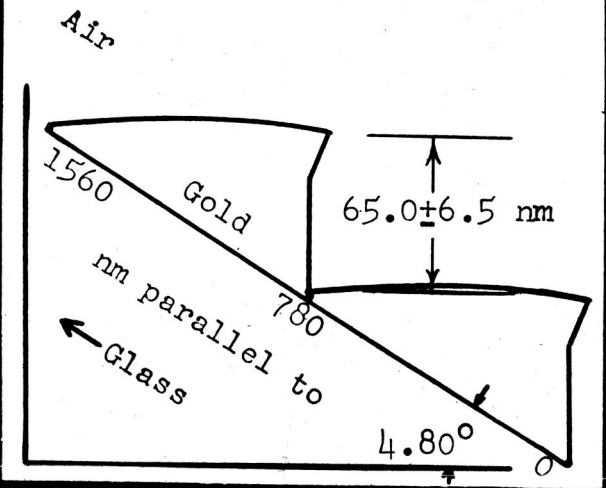


ELECTRON MICROGRAPHS

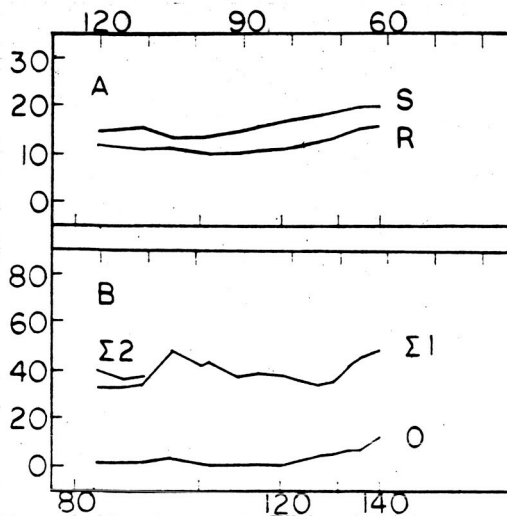
OBSERVATIONS

Substrate - (=33) Transfer film
 Deposition - 35 microtorr
 Electron gun, C crucible
 Au: 140 nm: .11 nm/sec
 Ruling - 1280/mm, oil
 .3 fringe burr
 Ruled well,
 Disturbed cement
 Excellent ruling
 Burnishing - Complete
 Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



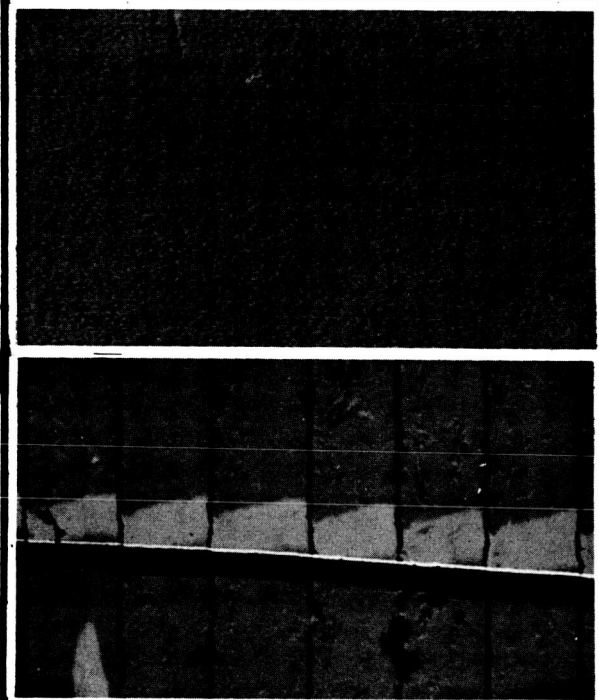
Wavenumber in Kilokaysers



Wavelength in nanometers
 A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 35

OBSERVATIONS

Substrate - (=36) Polished glass

Deposition - With NRL 37,38

50 microtorr

Electron gun, C crucible

Au: 460 nm: 5 nm/sec

Ruling - 1280/mm

.3 fringe burr

Ruled well except for some
nugget movement

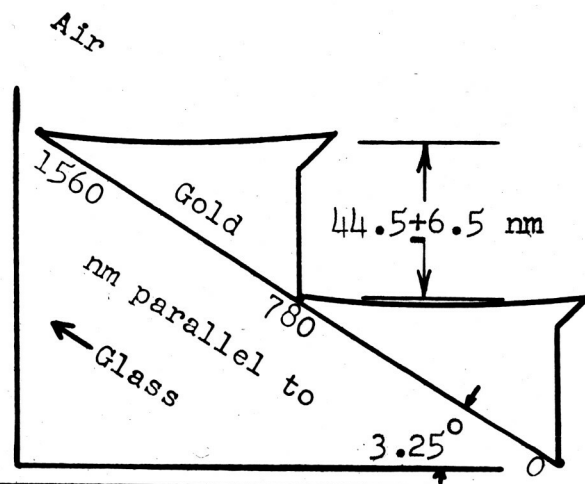
Good ruling

Burnishing - Complete

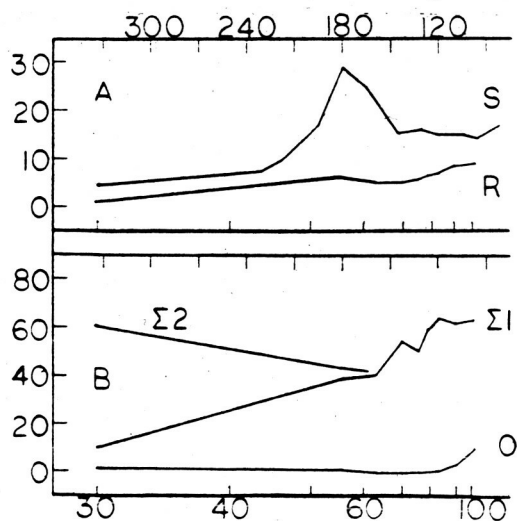
Groove edge wave - .2 groove



SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



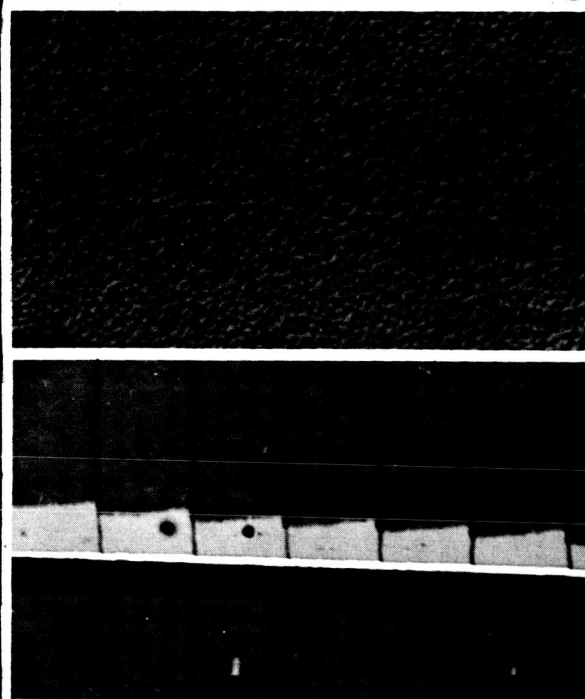
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 36

OBSERVATIONS

Substrate - (=35) Polished glass

Deposition - with NRL 37, 38

50 microtorr

Electron gun, C crucible

Au: 460 nm: 5 nm/sec

Ruling - 1280/mm,

.2 fringe burr



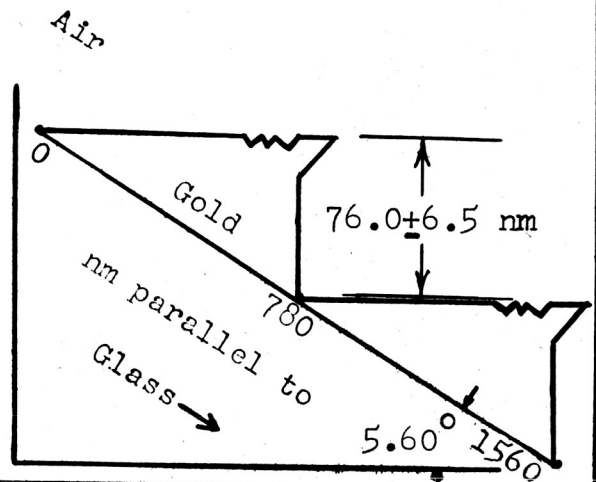
Many jumps and streaks
did not rule well

Groove bottom evident

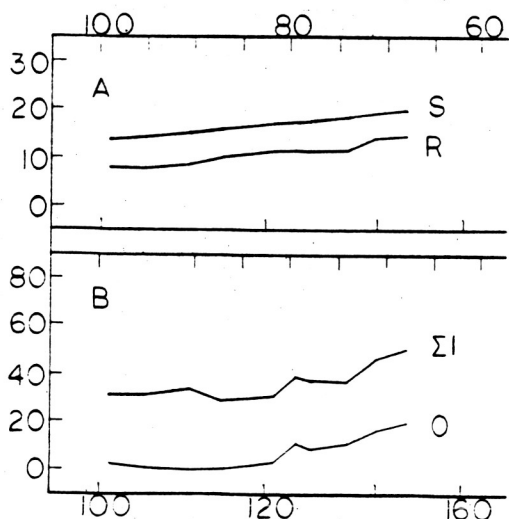
Burnishing - .9 Complete

Groove edge wave - .05 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



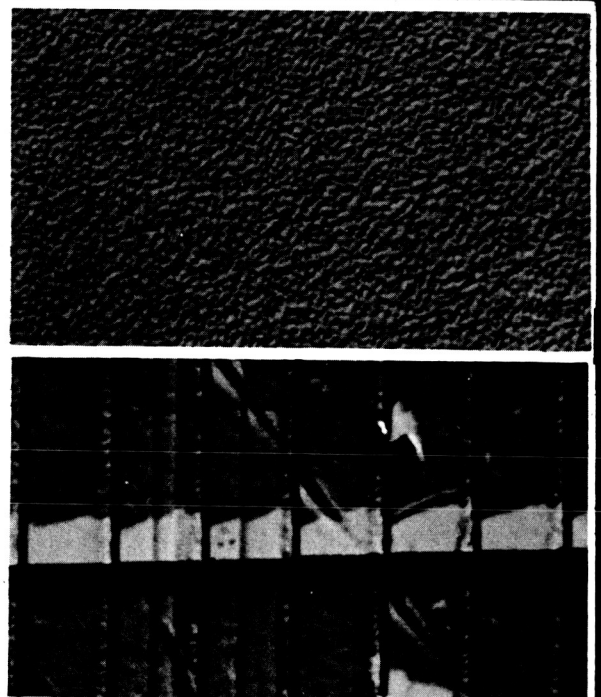
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

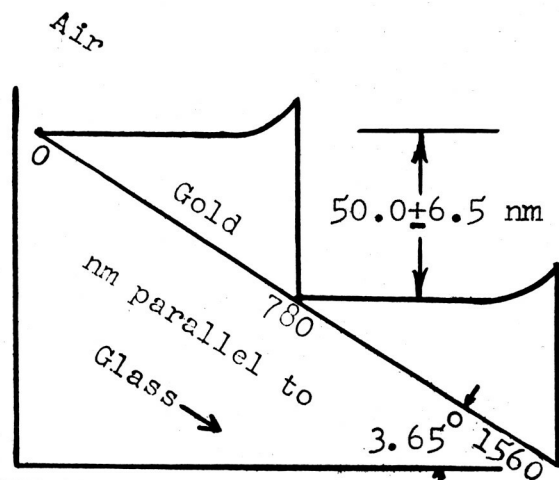
NRL 37

OBSERVATIONS

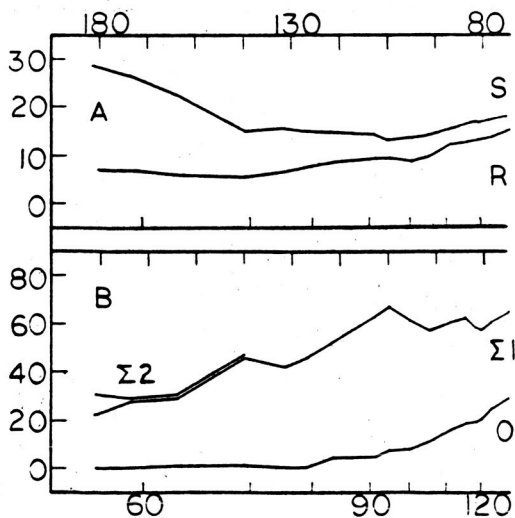
Substrate - (=38) Polished glass
 Deposition - with NRL 35, 36
 50 microtorr
 Electron gun, C crucible
 Au: 460 nm: 5 nm/sec
 Ruling - 1280/mm
 .2 fringe burr
 Some areas ruled very well
 Some not well
 Heavier jump marks and streaks
 Burnishing - .9 complete
 Groove edge wave - none



SCHEMATIC FORM OF GRATING PROFILE



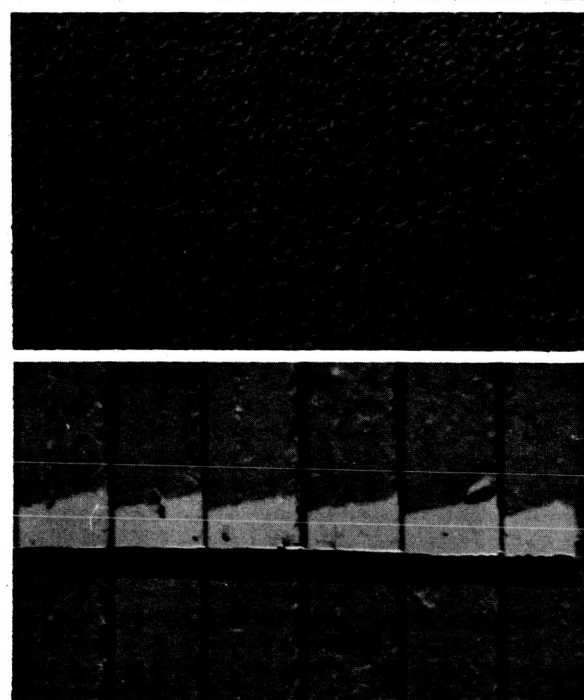
Wavenumber in Kilokaysers



Wavelength in nanometers
 A. Absolute reflectance of film and of "Standard (10/23/64)"
 B. Cumulative diffraction as % of "Standard" reflectance.


MEASURED AT NRL

→ 2,000 nm ←

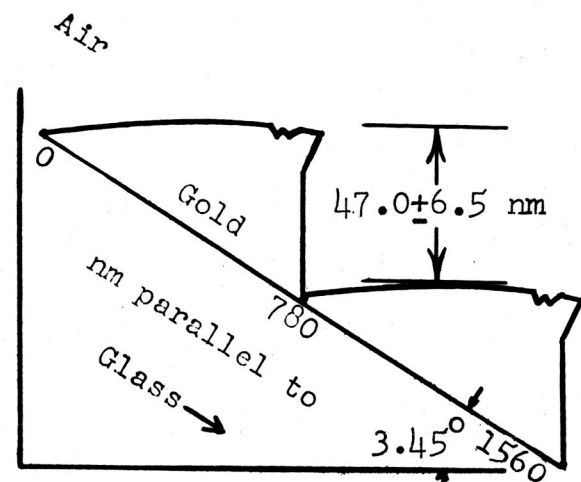


ELECTRON MICROGRAPHS

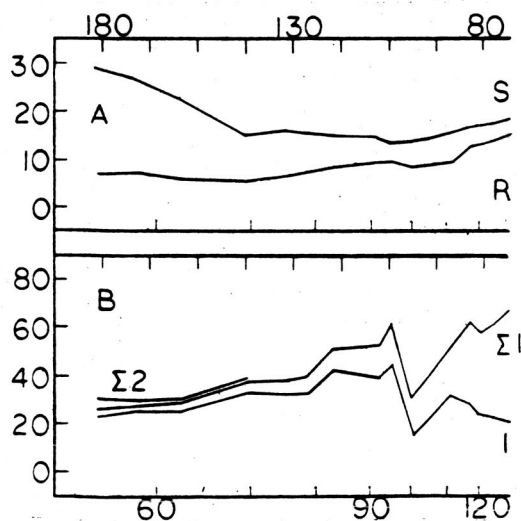
OBSERVATIONS

Substrate - (=37) Polished glass
 Deposition - with NRL 35, 36
 50 microtorr
 Electron gun, C crucible
 Au: 460 nm: 5 nm/sec
 Ruling - 1280/mm, 
 .3 fringe burr
 Jumps at nuggets,
 Ruled fairly well
 Not as bright as 37
 Burnishing - .8 complete
 Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

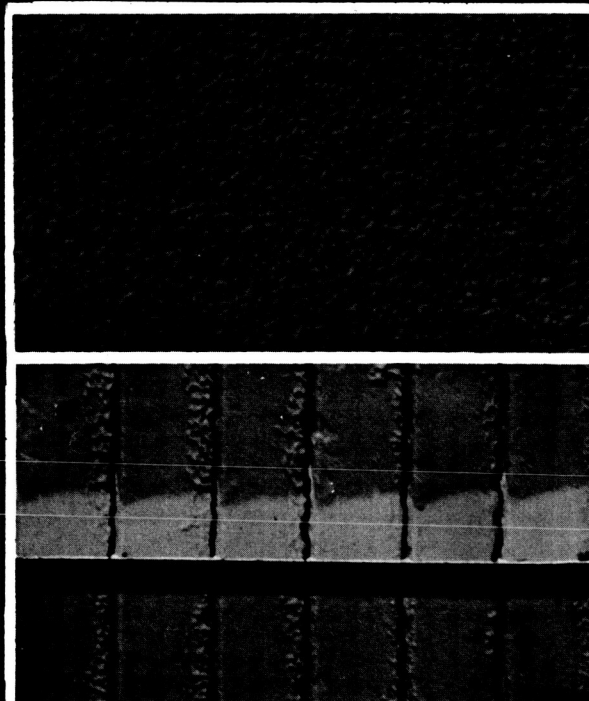


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffractance as % of "Standard" reflectance.


MEASURED AT NRL

→ 2,000 nm ←

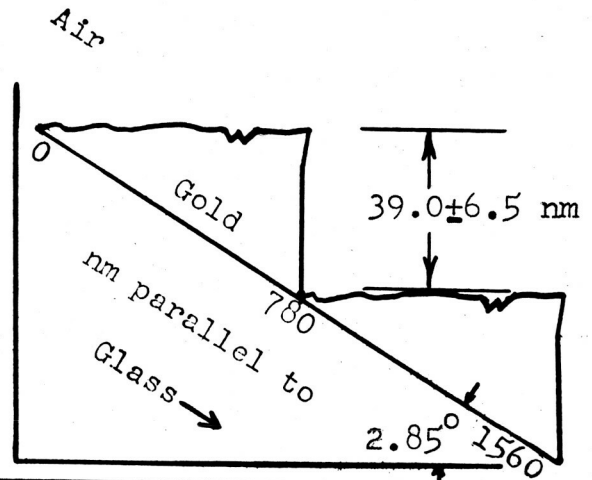


ELECTRON MICROGRAPHS

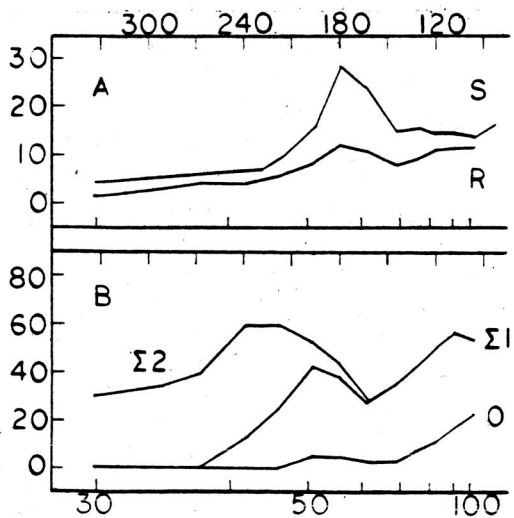
OBSERVATIONS

Substrate - (=40) Polished glass
 Deposition - with NRL 41, 42
 50 microtorr
 Electron gun, C crucible
 Au: 250 nm: 5.5 nm/sec
 Ruling - 1280/mm, 
 .3 fringe burr
 Double ruling may test
 engine quality mainly
 Similar to 3%, rarely good
 Burnishing - .8 complete
 Groove edge wave - .05 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

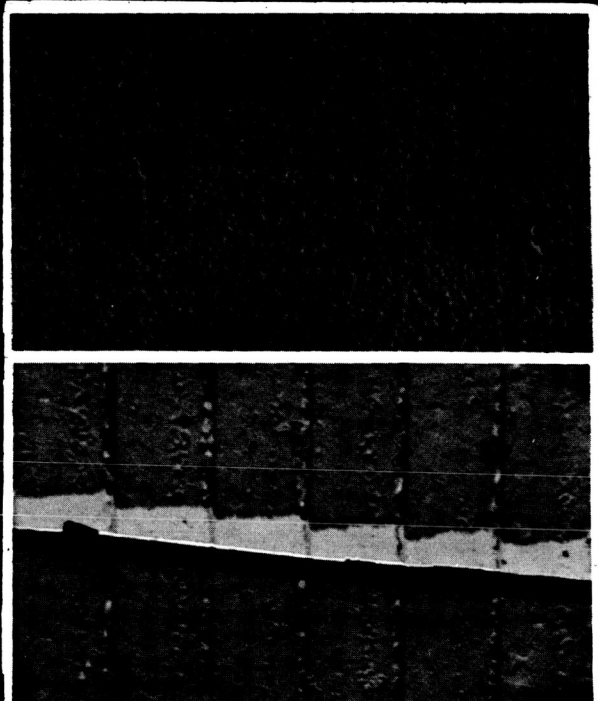


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
- B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 40

OBSERVATIONS

Substrate - (=39) Polished glass

Deposition - with NRL 41, 42
50 microtorr

Electron gun, C crucible

Au: 250 nm: 5.5 nm/sec

Ruling - 1280/mm



.4 fringe burr

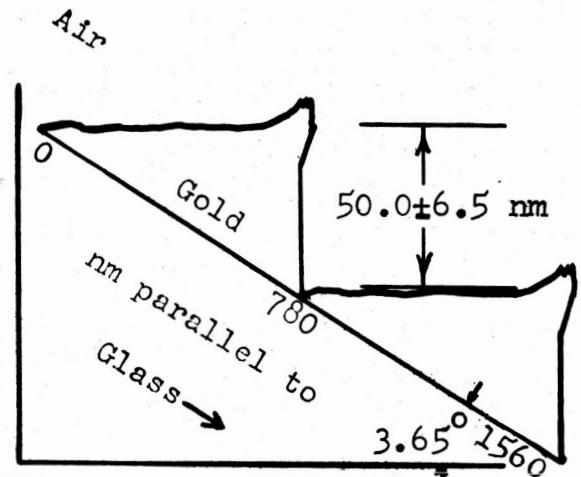
Many nuggets, jumps,
and streaks

Better than 39

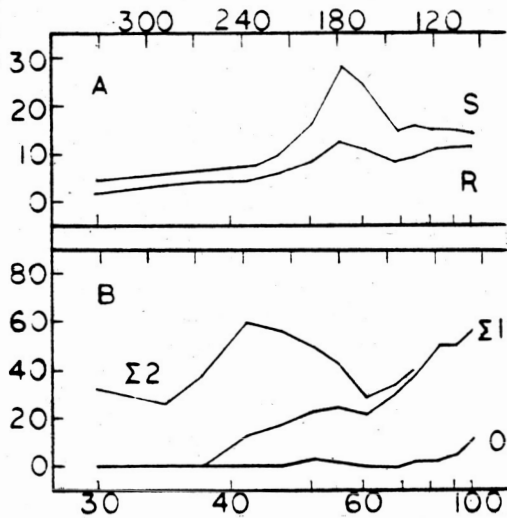
Burnishing - .9 complete

Groove edge wave - .05 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



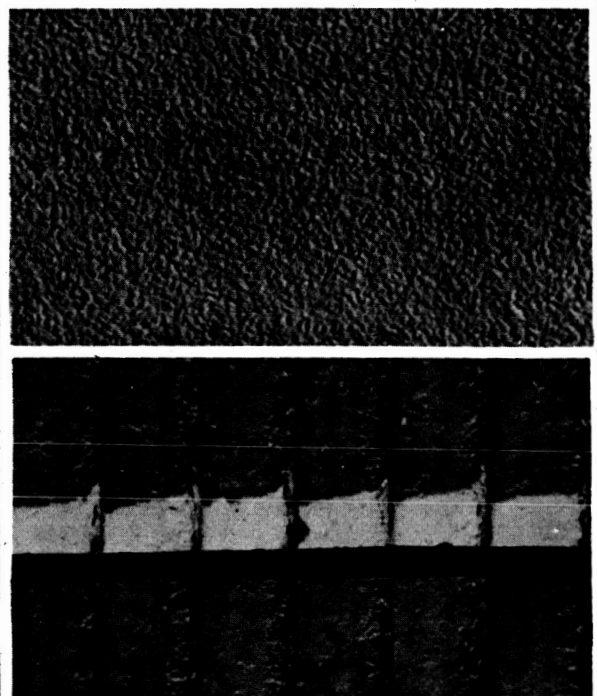
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)"

B. Cumulative diffraction as
% of "Standard" reflectance.

MEASURED AT NRL

2,000 nm



ELECTRON MICROGRAPHS

NRL 41

OBSERVATIONS

Substrate- (=42) Polished glass

Deposition - With NRL 39,40
50 microtorr

Electron gun, C crucible

Au: 250 nm: 5.5 nm/sec

Ruling - 1280/mm,

.3 fringe burr

Test lines better than
single, ruling

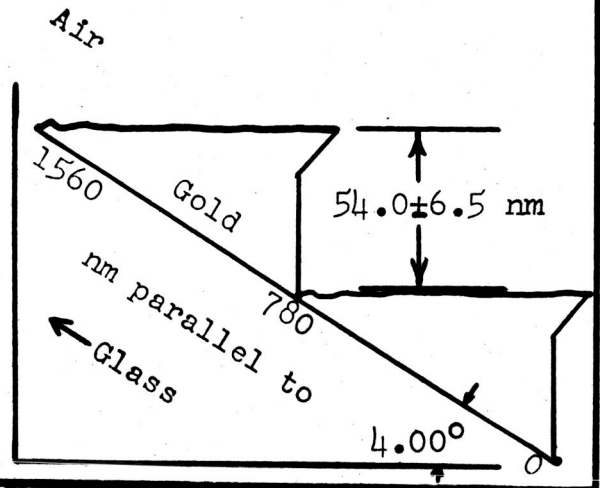
Did not rule well, streaks

Burnishing - Complete

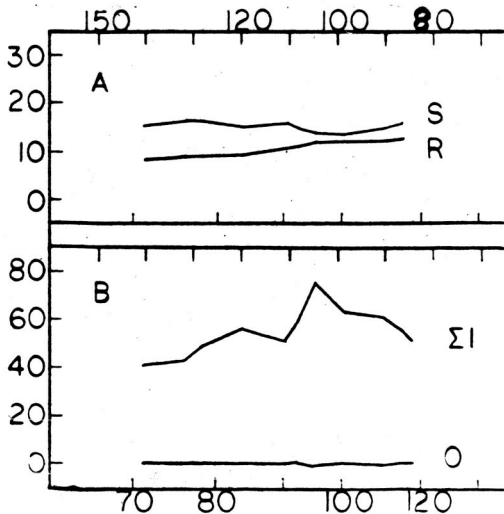
Groove edge wave - .3 groove



SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



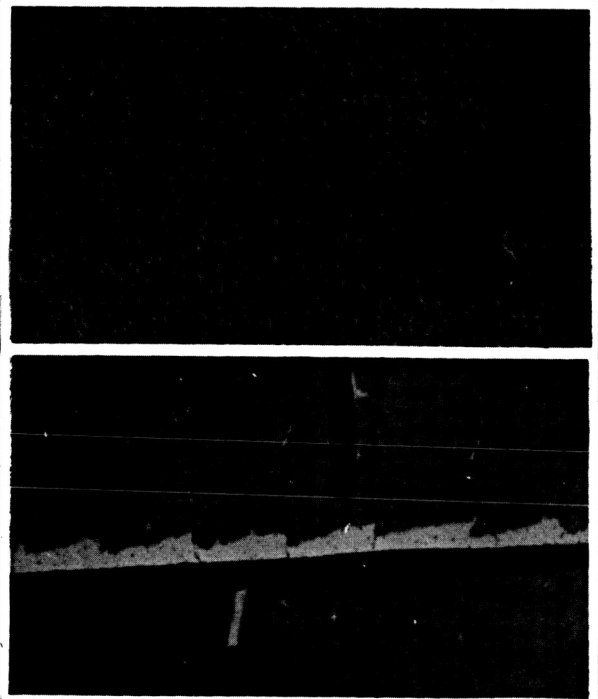
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 42

OBSERVATIONS

Substrate-(=41) Polished glass

Deposition - With NRL 39,40

50 microtorr

Electron gun, C crucible

Au: 250 nm: 5.5 nm/sec

Ruling - 1280/mm

.3 fringe burr

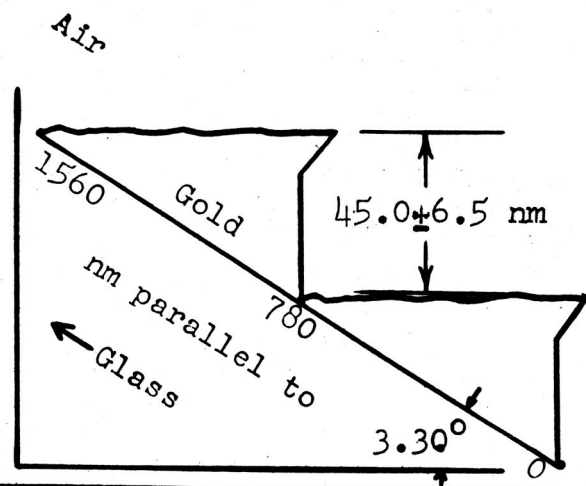
Few ruling streaks, fringes less distinct

Groove shape the same as 41

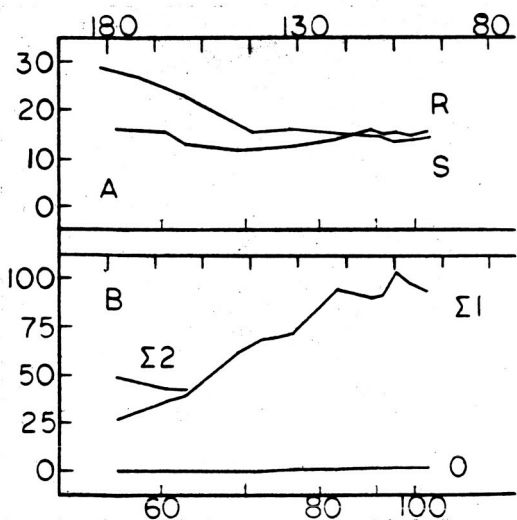
Burnishing - .9 complete

Groove edge wave - .25 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



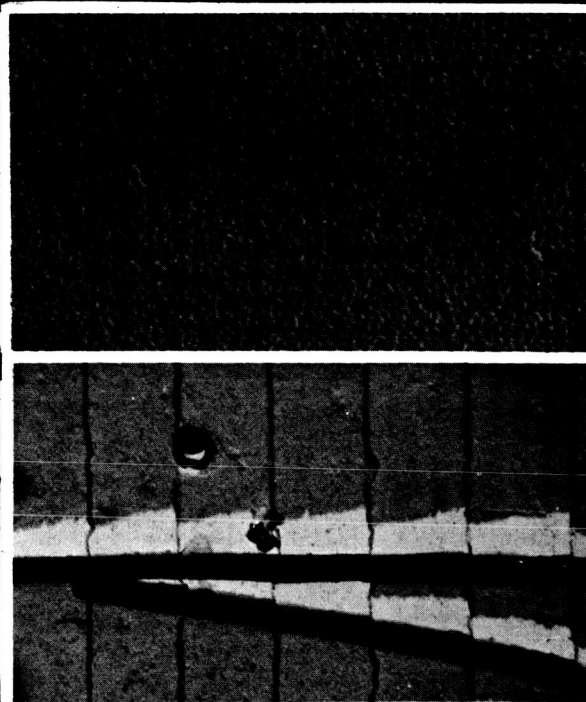
Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)".

B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

2,000 nm



ELECTRON MICROGRAPHS

NRL 43

OBSERVATIONS

Substrate - Polished plate

Deposition - With NRL 44

40 microtorr

Electron gun, C crucible

Au: 320 nm: 3.5 nm/sec

Ruling - 1280/mm

.2 fringe burr

some gold adhesion,

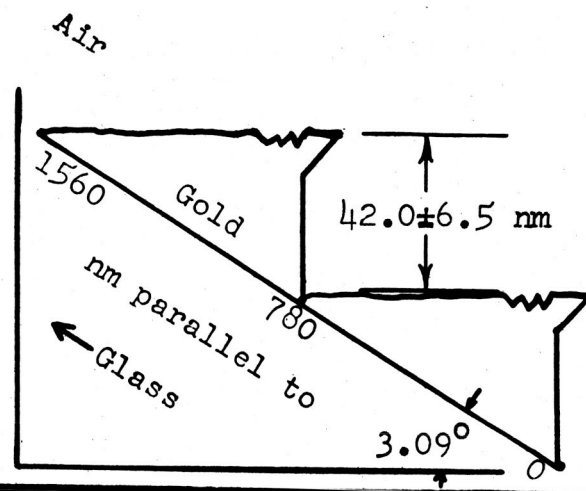
ruled well, some streaks

Fringes from grooves indistinct

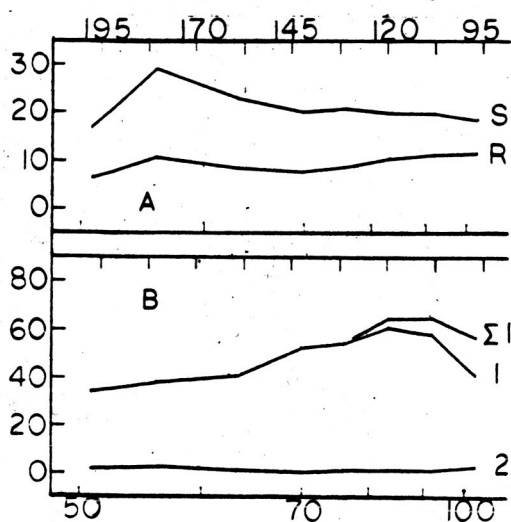
Burnishing - .9 complete

Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



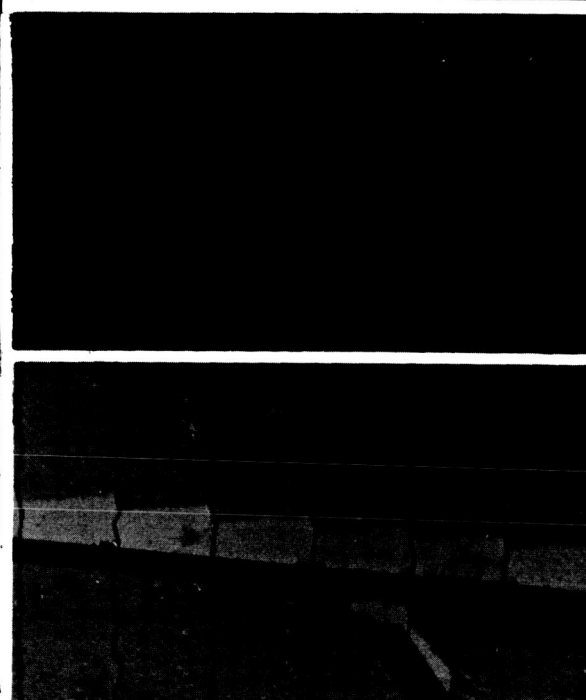
Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)"

B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

2,000 nm



ELECTRON MICROGRAPHS

NRL 44

OBSERVATIONS

Substrate - Shined glass plate

Deposition - With NRL 43

40 microtorr

Electron gun, C crucible

Au: 320 nm: 3.5 nm/sec

Ruling - 1280/nm

.2 fringe burr

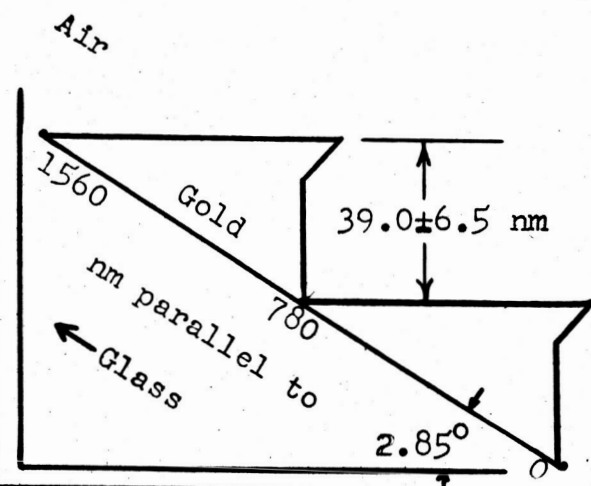
Some gold adhesion,
ruled well

Much groove width variation

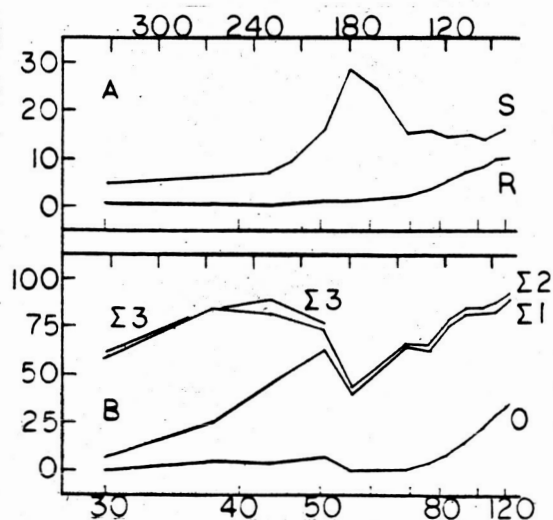
Burnishing - Complete

Groove edge wave - .3 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

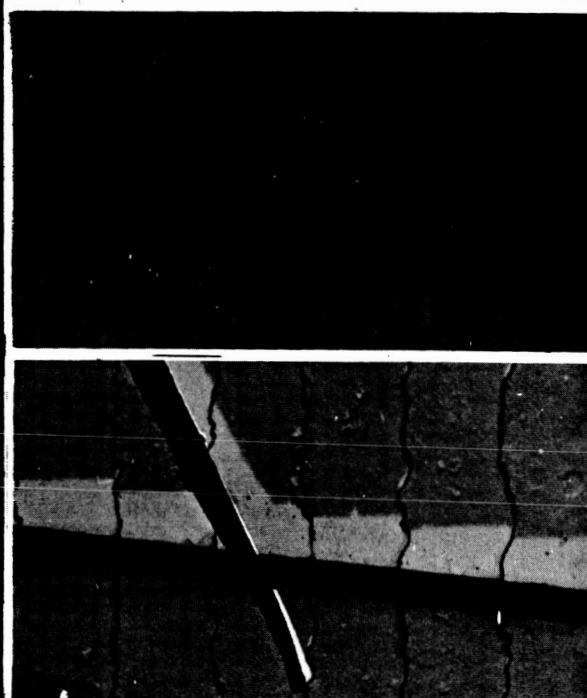


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)"
- B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



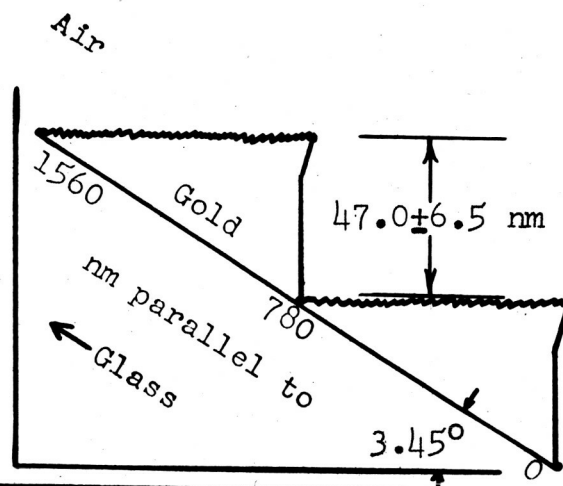
ELECTRON MICROGRAPHS

NRL 45

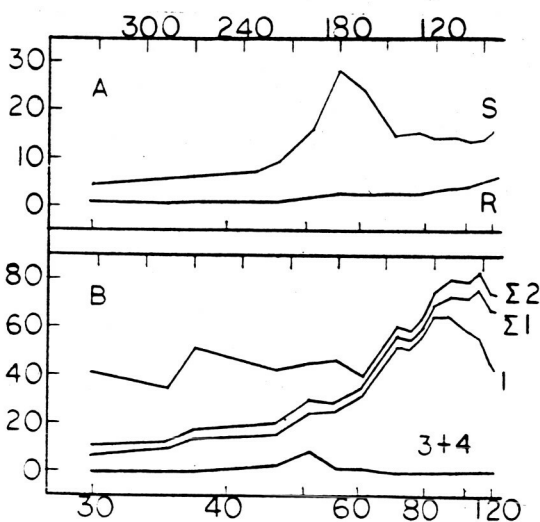
OBSERVATIONS

Substrate - Polished glass
 Deposition - 35 microtorr
 Electron gun, C crucible
 Au₉₄ Ge₆: 300 nm: 1.8 nm/sec
 Ruling - 1280/mm
 .3 fringe burr
 Nuggets disturbed diamond
 Some streaks
 Difficult to burnish
 Burnishing - Complete, poor
 Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

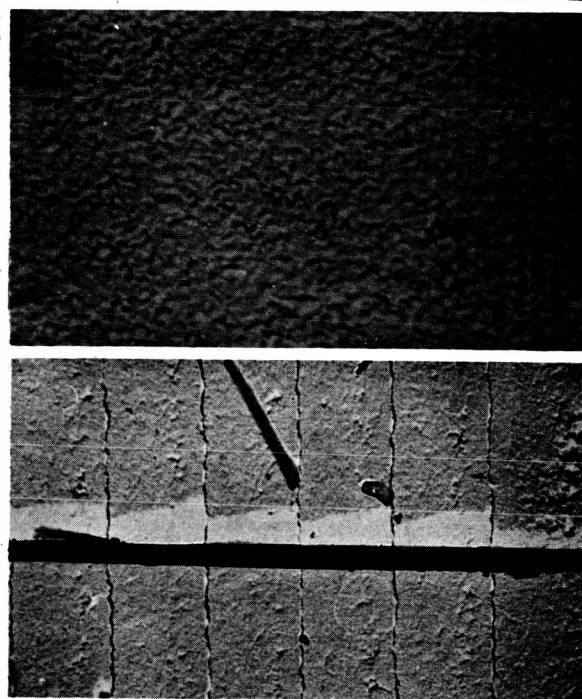


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)"
- B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 46

OBSERVATIONS

Substrate - Polished plate

Deposition - With NRL 47

50 microtorr

Electron gun, C crucible

Au: 400 nm: 4.5 nm/sec

Ruling - 1280/mm

.3 fringe burr

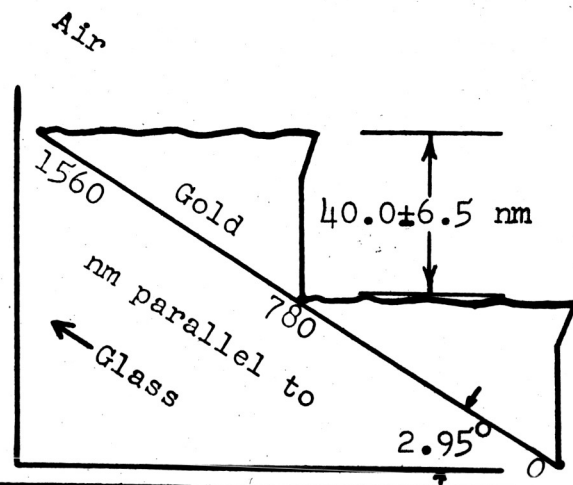
Diamond not bothered
by nuggets

Good ruling

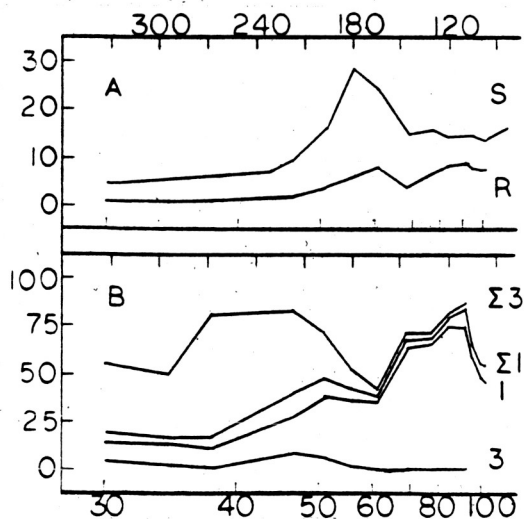
Burnishing - Complete

Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



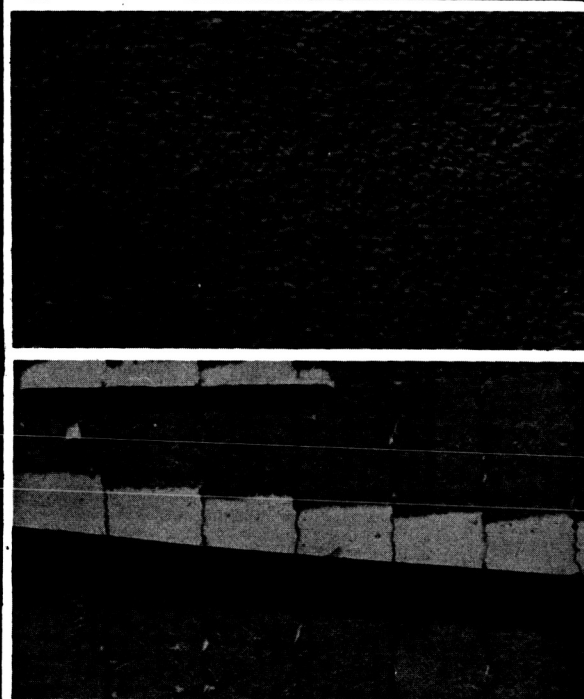
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

2,000 nm



ELECTRON MICROGRAPHS

NRL 47

OBSERVATIONS

Substrate - Under-liquid polish

Deposition - With NRL 46

50 microtorr

Electron gun, C crucible

Au: 400 nm: 4.5 nm/sec

Ruling - 1280/mm

.2 fringe burr

Au adhesion to tool

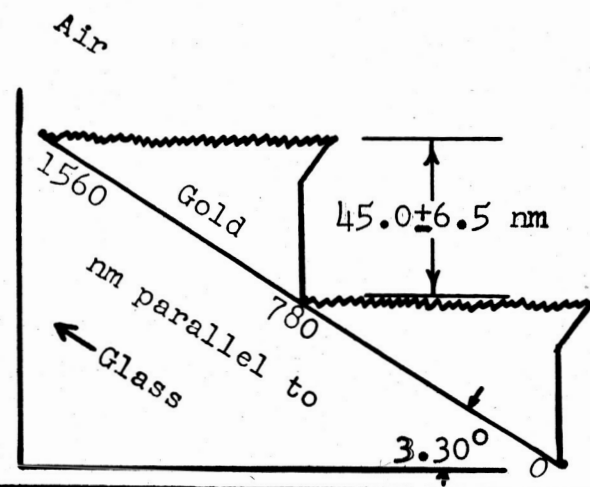
Groove shape good

Rough surface of grooves

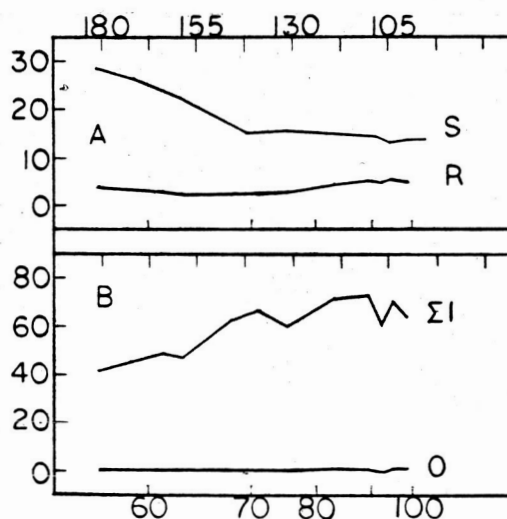
Burnishing - Complete, rough

Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



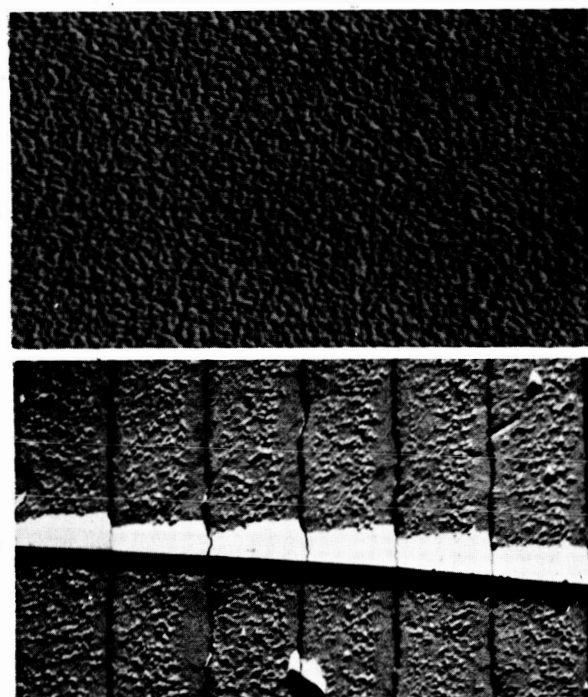
Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)"

B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←

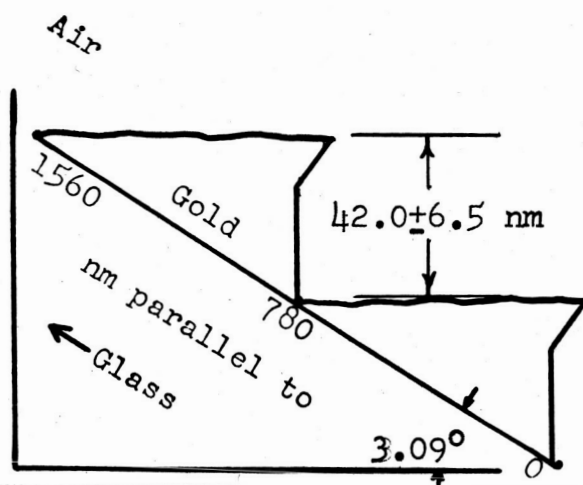


ELECTRON MICROGRAPHS

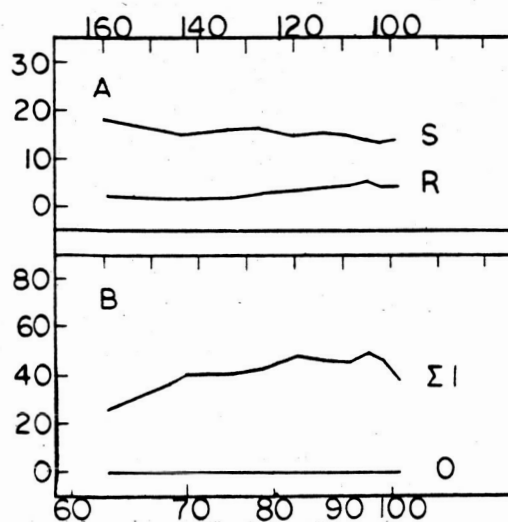
OBSERVATIONS

Substrate - Polished glass
 Deposition - 12 microtorr
 Joule heat, Mo boat
 Au: 440 nm: 22 nm/sec
 Ruling - 1280/mm
 .3 fringe burr
 Streaks due to complete evaporation from boat
 Poor groove form
 Burnishing - Complete
 Groove edge wave - .4 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

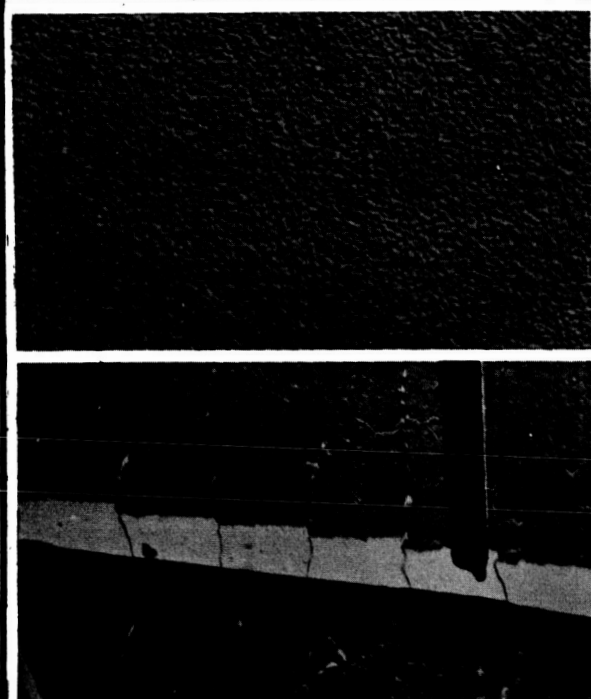


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)"
 B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←

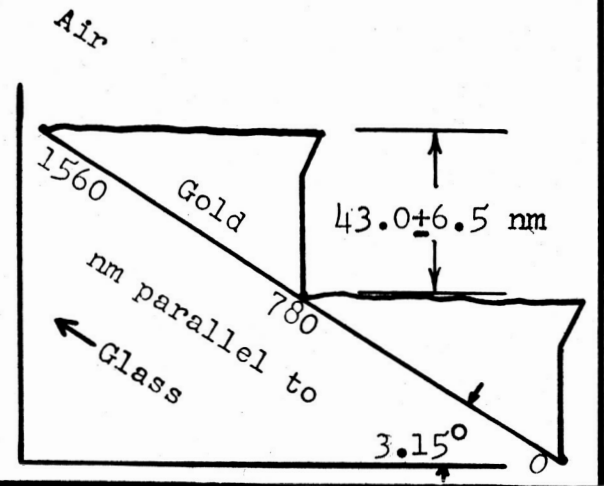


ELECTRON MICROGRAPHS

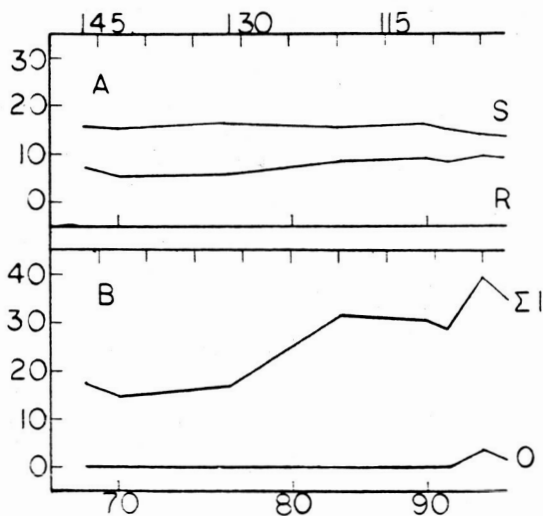
OBSERVATIONS

Substrate - Polished glass
 Deposition 11 microtorr
 Joule heat, Mo boat
 Au: 130 nm: 8.5 nm/sec
 Ruling - 1280/mm
 .3 fringe burr
 Serious gold adhesion
 after early grooves
 Poor overall
 Burnishing - Complete
 Groove edge wave - .1 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers

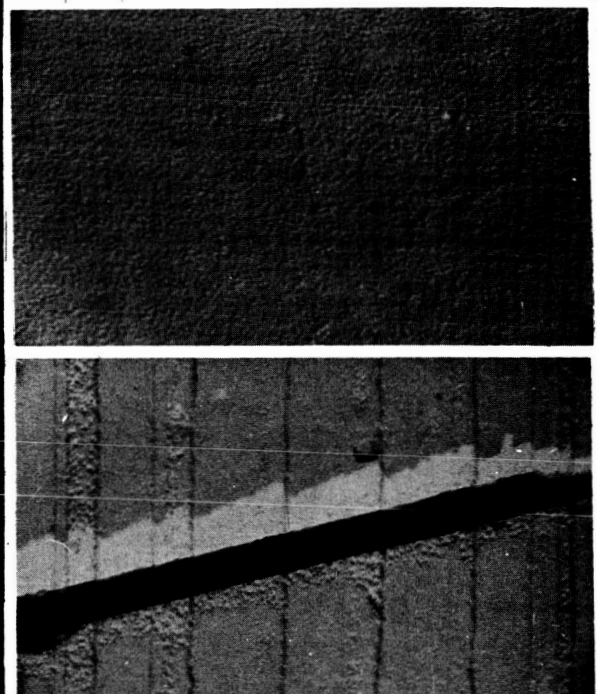


Wavelength in nanometers

- A. Absolute reflectance of film and of "Standard (10/23/64)".
 B. Cumulative diffraction as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



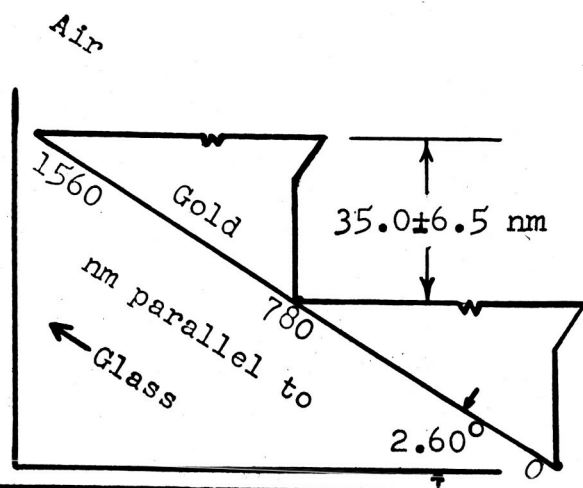
ELECTRON MICROGRAPHS

NRL 50

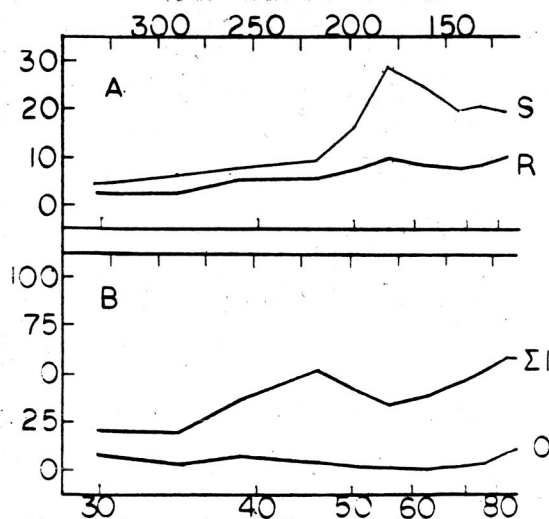
OBSERVATIONS

Substrate - Polished glass
 Deposition - 9.5 microtorr
 Joule heat, Mo boat
 Au: 270 nm: 13.5 nm/sec
 Ruling - 1280/mm
 .3 fringe burr
 Serious gold adhesion,
 some spots like 48
 Did not rule well
 Burnishing - .9 complete
 Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



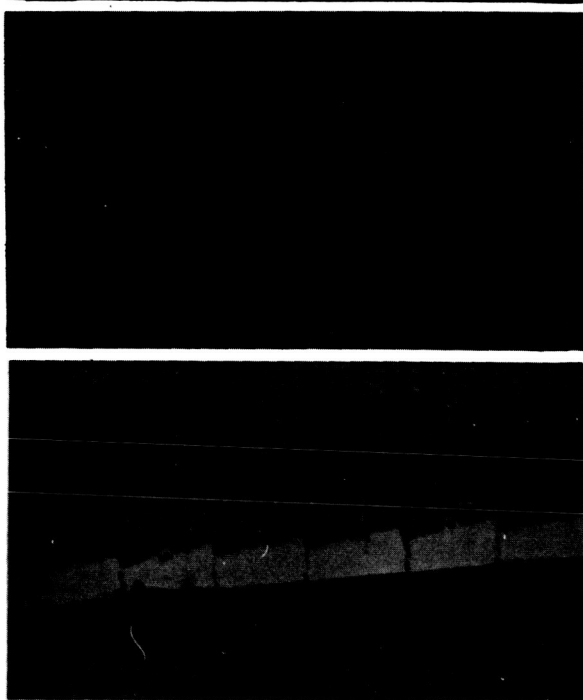
Wavenumber in Kilokaysers



Wavelength in nanometers
 A. Absolute reflectance of film
 and of "Standard (10/23/64)"
 B. Cumulative diffractance as
 % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 51

OBSERVATIONS

Substrate - Shined plate

Deposition - With NRL 52

30 microtorr

Joule heat, Mo boat

Au: 160 nm: 16 nm/sec

Ruling - 1280/mm

.25 fringe burr

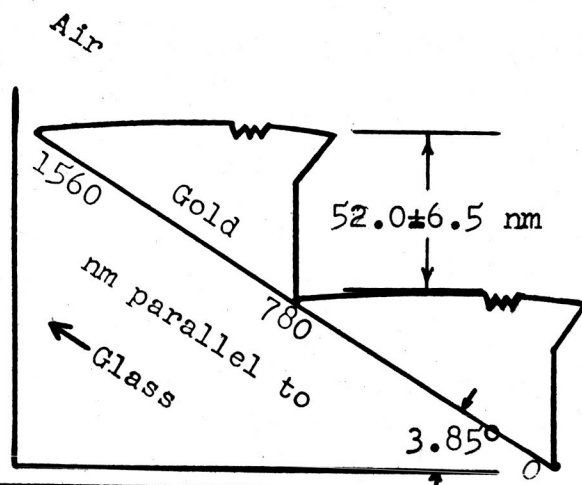
Some Au adhesion and streaks from it

Good ruling

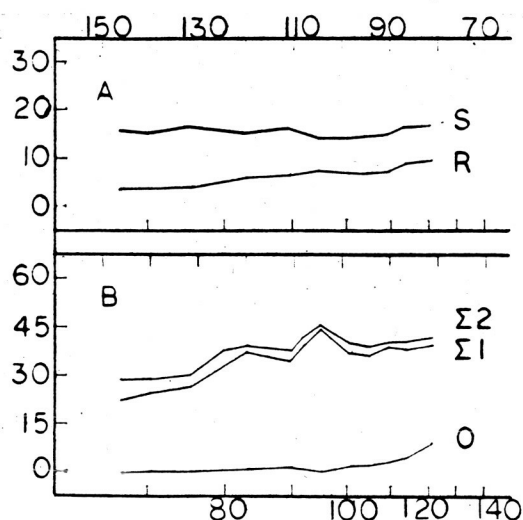
Burnishing - Complete

Groove edge wave - .2 groove

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



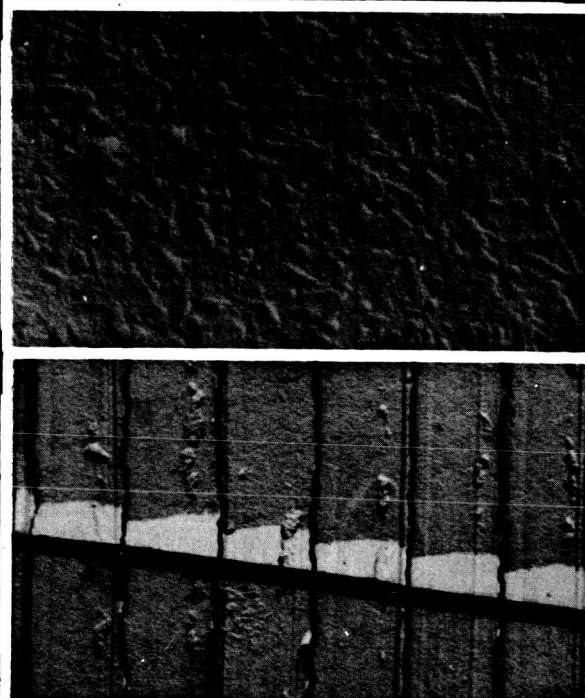
Wavelength in nanometers

A. Absolute reflectance of film and of "Standard (10/23/64)"

B. Cumulative diffractance as % of "Standard" reflectance.

MEASURED AT NRL

→ 2,000 nm ←



ELECTRON MICROGRAPHS

NRL 52

OBSERVATIONS

Substrate - Polished glass

Deposition - With NRL 51

30 microtorr

Joule heat, Mo boat

Au: 160 nm: 16 nm/sec

Ruling - 1280/mm

.3 fringe burr

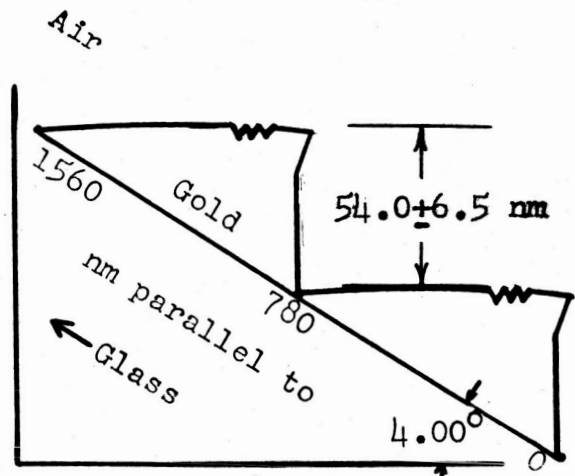
Some heavy streaks due
to Au adhesion

Similar to 51

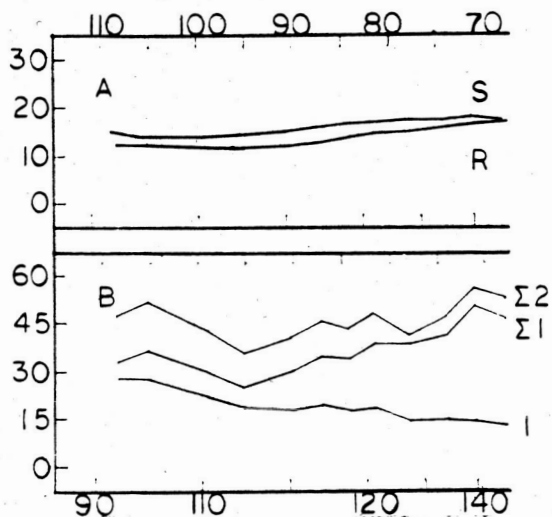
Burnishing - Complete

Groove edge wave - .1 fringe

SCHEMATIC FORM OF GRATING PROFILE



Wavenumber in Kilokaysers



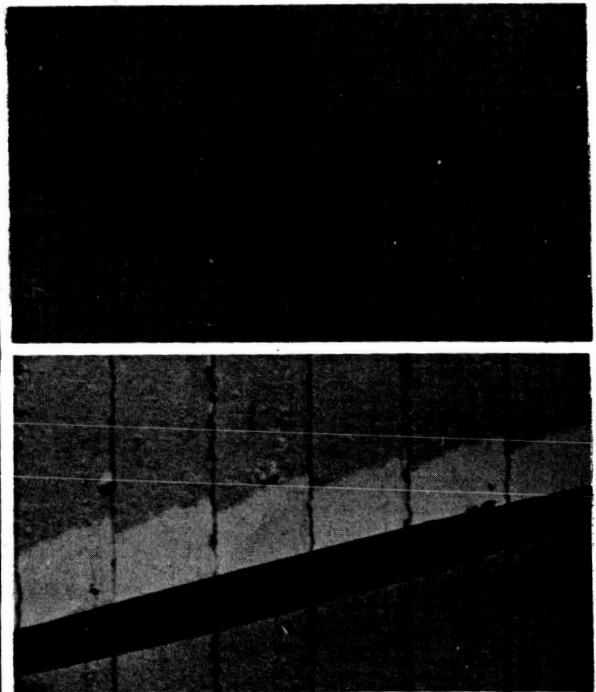
Wavelength in nanometers

A. Absolute reflectance of film
and of "Standard (10/23/64)".

B. Cumulative diffractance as
% of "Standard" reflectance.

MEASURED AT NRL

2,000 nm



ELECTRON MICROGRAPHS